SOIL BACTERIA AND CELLULOSE

DISCOVERY

A Monthly Popular Journal of Knowledge

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A DEEP SEA FISHERMAN.

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Editorial Notes.

Science is a difficult salient to defend and scientists in general (I use the word with a full recognition of its limitations, its iniquities, and the contemporary correspondence in *Nature* which has, as yet, failed to bring to light a convenient synonym) have, it appears, somewhat unreasonably based their claims to be benefactors of humanity in general on the progress of medical knowledge. I too, was happily and vaingloriously deceived by this, and never thought otherwise until some wiseacre in a club corner said "You are entirely wrong, loose and haphazard in your thinking. Your own special pet subject is military history, *and if it had not been for the doctors you know as well as I do that war on a nationwide scale would have been impossible.*" The ensuing twenty minutes of debate was perhaps more entertaining than useful, because those serious matters tend in a club atmosphere to become a pivotal point for the play of cheerful and somewhat personal dialogue, rather than deep research into the principles of the argument.

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It stresses the other side of the shield. That awkward business that we would all like to ignore. In the old days it was impossible to keep more than say fifty thousand men in the field together for more than six weeks. If an army corps was so flung together it began to suffer from a variety of pestilences which we now recognize as due to infection by the minor horrors of war, bugs, lice and equivalent insects. Thanks to medical research we now know our enemies. We have reduced the percentage of casualties from the point where disease and sickness killed four men and the enemy some odd percentage of one, to the point where the enemy had to kill four to the percentage of one that died of sickness. This triumph we owed to the medical men—and it cancelled out. We still have to face the argument, or the paradox, of the man who states that it was the progressive and extremely important work of the medical man which enlarged the limits of practicable modern warfare to embrace the civil population as well as the troops in the field. The answer is that though the medical discoveries may alleviate the horrors of warfare in a fairly equal proportion when the facts are known and met by capable western powers. It is the application of this knowledge in peace time which really counts. Tuberculosis is nearly conquered. Cancer? Well, the present state of cancer research, and what one may for want of a better term bespeak as the general attack on the cancer front, is about where the anti-tuberculosis combatants were fifteen years ago. It is a very hopeful position. Nobody is likely to come out with some sudden nostrum or cureall, but day by day, week by week, the concentrated spearpoint of scientific knowledge is being brought to bear on the problem. The whole thing is being tackled from its own remote beginnings, those mysteries of cell division and morbid differentiation that at the moment we know so pitifully little at all about. It is sheer spadework. That all-essential dreary unsensational hard building up process, where apparently unimportant fact on unimportant fact is built together until somebody sees in the jigsaw puzzle bits that can be brought together and be built together into a coherent theory of attack.

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To-day we are at a pause, for the best weapon of all, the microscope, is limited by that infinitesimal

dimension the ultimate limit of what we can see; that which is large enough to be resolved by a wave-length of light. The principles of the ultra-microscope and applications of photography may help us to "see" the invisible, to render perceptible to our critical senses matters normally beyond the scope of our finest instrument-aided vision. We may yet find in the visible shadow and the trace track of the invisible a clue to the solution of our plagues and that dark body of death which, by a cowardly paradox so long as it does not come by violence, we deem natural. Yet the conquest of an individual disease is seldom the work of one man, but the ultimate result of the work of many observers, many inventors, and many men of science not necessarily doctors.

* * * * *

It is a matter for thought, the real value of our science and pseudo science to-day. It seems to be a sufficiency in itself to the smaller minds. They are happy with it, content and perhaps untroubled in a blissful self-sufficiency. The workaday world sometimes mocks at their self-satisfaction, and without qualification, but with a more delicate sense of the realities, jeers at the certainties of a new-fledged B.Sc. There is, perhaps, nothing always excepting a classicist quite so practically unemployable as a psychologist, expert in psychology but unversed in vulgar but necessary life. Contact with realities evokes responses in his ductless glands and a reluctant surrender to economic forces. The mental mechanism appears to adjust itself automatically or at least diplomatically, and after a year or two he is much as other men are. The scientific worker is better equipped than the psychologist. He, at least, has something practical to offer. The scientist often claims, with a large proportion of right, that his discoveries, made for the benefit of humanity, all too often fall into the hands of the wicked capitalist. This attitude is sound, but it must be said that it is blemished by the relatively large number of other scientific workers whose lives are blighted by their failure to find a wicked capitalist to exploit their discoveries. They seem to be a majority, but at the same time their discoveries mostly appear to be in a half-fledged state needing further financial support and deeper research work. It is a hard life; still, if anybody has anything really promising and profitable in the way of ideas, there are folk I know willing to listen to them.

* * * * *

The incident of the month has undoubtedly been the action of the City of London Authorities concerning St. Paul's Cathedral. It has been a remarkably efficient move, and has probably saved the cathedral. The fee of the surveyor who called the Dean and Chapter to order was, I believe, thirteen shillings and eightpence according to an old statute. The public responses to *The Times* appeal has, to the time of writing, been remarkably good, and is a heartening instance of the generosity of the British public's support for any cause in which they are really interested. It is wonderful how the money has been subscribed for this. Let us express a pious hope that scientific appeals for funds will be no less well supported. It is something of a good augury for the future. We are, it would seem, coming to a period of almost unromantic sincerity, a rather crude plain-speaking period of commonsense and recuperation. The end of the nineteenth century Georgian period seems to come closest to it in history and if it leads us to another Victorian era I, for one, can forgive many possible lapses in aesthetics if it brings back anything like the old era of peace, prosperity, and real golden sovereigns. There are a good many signs about which give some substance to the idea.

* * * * *

The re-afforestation of that hideous eyesore the Black Country is again being talked about, and the Society for the Abatement of the Smoke Nuisance have had a stroke of luck which ought to bring them the support of every wealthy shopkeeper in London. Three days fog just before Christmas followed by three days more at the height of the sales season should prove one of the most powerful arguments in favour of the legal restriction of atmospheric pollution, that a skilled propagandist can put forward.

* * * * *

The Royal Society of Medicine's investigation into the Abrams Electronic Treatment, vulgarly known as the "Abrams Magic Box," have had an unexpected result. There seems to be something in it. Not necessarily all or even anything that its partisans claim for it, but something at present inexplicable. Sir Thomas Horder and his assistant physicists on the committee have still to find out why the apparatus produces certain effects. A very strong American committee failed to find any ground for supporting Abram's claims, and at the time of writing and with only Press reports to hand, it is not clear that the British committee have found any phenomena which substantiate the claims for curative or diagnostic capacity put forward by followers of the electronic method. It is obvious that the inquiry must continue and DISCOVERY will have an article on the subject so soon as adequate facts are available.

Bird-Watching Through Binoculars

By H. Mortimer Batten, F.Z.S.

Author of "Habits and Characters of British Wild Animals," "Inland Birds," "Prints from Many Trails," "The Badger Afield and Underground," etc.

The skilled observer of bird-life has to practice the wiles of a deer stalker. His glasses are the weapons on which he relies, and good binoculars are as important to him as fine tackle to an angler.

To what extent the pleasure and interest of a ramble in the country is increased by carrying a pair of good binoculars, can only be realized by those who are accustomed to the "company" of such an article, and this applies to touring by car quite as much as to walking or cycling. Once having acquired the habit of carrying binoculars, one feels hopelessly restricted without them, yet how many people tour the lakes or the Highlands or wherever it may be without thought as to how much their powers of observation might be increased by this very simple provision? In Scotland their use is more general than in England—through the influence of the deer forests, probably—and I know naturalists and sportsmen and motorists who would no more think of going out without "glasses" than without the usual article of headgear. I must say that by long familiarity I myself feel that a very essential part is missing when for some reason the binoculars are at the wrong end.

Essential Practice.

To obtain the best results from binoculars a little familiarity with their use is necessary, and the greater the magnification the more strongly does this apply. One learns to use them just as one learns to shoot, though, of course, a great deal more rapidly. For example, some far-distant object in a broken landscape is sighted with the naked eye, and the man who is used to glasses picks it up almost instantly. His companion may be less experienced, with the result that it requires several seconds to hit the mark, and perhaps a chance is gone for all time. Or again, the inexperienced hand often focuses upon quite the wrong object, and does not realize his error till too late. I have known this to happen over and over again in the deer forests, where telescopes are more commonly used. For general use, however, the telescope is too unwieldy, and binoculars are now so powerful and clear that they meet all ordinary requirements. Moreover, the scope of the two is quite distinct. The telescope is at its best for carefully and systematically quartering the ground in search of objects invisible to the naked eye, and it is apt to fall short when one wishes immediately to obtain a sharp focus upon some object seen at a distance. Personally, I use binoculars at all times, and only when special circumstances demand are they laid aside for the telescope.

How to Watch.

I think the whole art in using binoculars is based on taking a line between definite landmarks. One does this unconsciously, generally by picking out some feature on the distant skyline and another feature near at hand, the object of attention being in direct line between the two. Do not try to raise the binoculars direct to the object, but raise them to the skyline object then lower them to the foreground object (or vice versa), and thus having obtained the line, travel steadily along it. Similarly, having found an object with the glasses, mark its whereabouts very definitely by decided objects before moving the lenses. With a little practice all this is done instinctively, and one learns, moreover, to hold the glasses perfectly steadily, an essential at first difficult. Steadiness can often be assisted by placing the first and second fingers against the temples on either side.

For the study and photography of bird and animal life, good binoculars are, of course, essential, and a few notes from my own experiences may perhaps be of interest. Last spring I paid a visit to the breeding haunts of a pair of peregrines, their cliff rising abruptly for a matter of four hundred feet from the sea. By gaining a rocky promontory half a mile or so up the coast, one obtained from its summit an uninterrupted view of the cliff face with its crowds of cosmopolitan gulls thronging the lower shelves, and forming a grotesque spectacle, even to the naked eye. By the use of the glasses, however, one could pick out each individual bird, even to the peregrine himself, perched aloft and aloof on his look-out tower. So I lay for hours watching the strange cosmopolitan throng, returning the next day to the same place. I several times saw the peregrine descend and strike down puffins, but once only did I obtain a glimpse of the hen bird, whose eyrie was as usual overhung. One

Red Deer are among the shyest of beasts. A breath of wind carrying the scent of man and they are away. Here is a remarkable photograph of a herd crossing a forest boundary.

of the most interesting incidents was a fight between two herring gulls in which they both struck the rocks with considerable force. One of them fell to the sea, and went drifting off, probably mortally injured. The other gulls gathered round in a state of great agitation, alighting on the surface, so that in due course I lost the injured bird among the hundreds which dotted the sea. I also watched a grey seal on some rocks over a mile away—in fact I was enabled, by the use of good glasses, to enter into the affairs of all those sea folk with an intimacy which would otherwise have been impossible.

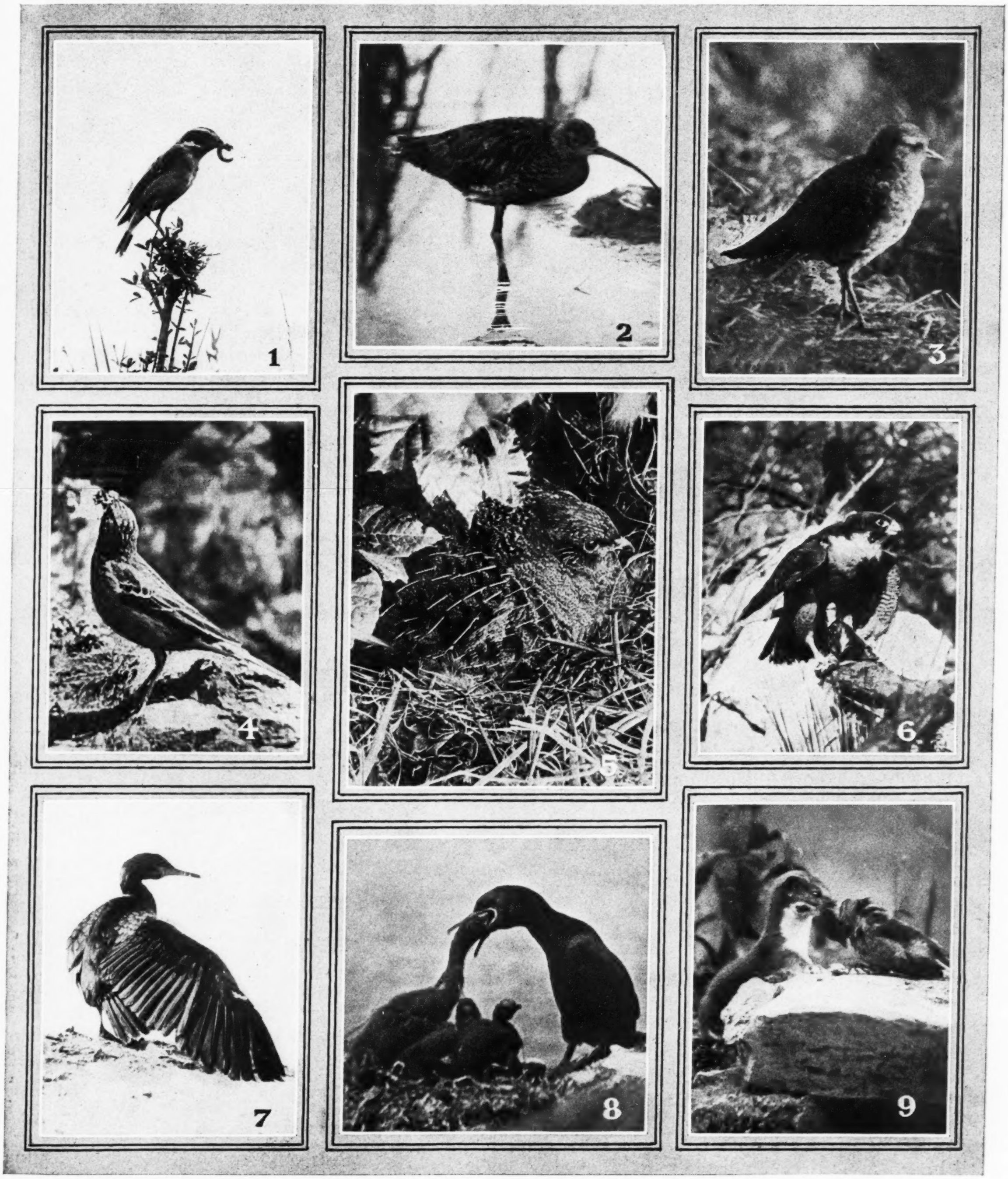
In the spring of the year the courtship of birds can be very closely studied, and affords a subject of entrancing interest. I have watched the lapwings go through all their strange antics, the male bowing and pivotting between intervals of scraping out sham nests by way of encouragement to his lady. The courtship of the common partridge is also very interesting, and can be observed by anyone in the very early spring—rather during the tail end of winter. No bird makes love more prettily and attractively than the little brown birds of our homesteads, and one cannot watch them without acquiring a very real sense of sympathy for them.

Ponds and swamps where bird life is abundant usually afford ample grounds for exploration, in this case every yard of the rushy margins being quartered over and over again. I have watched curlews and redshanks approach their nests with the utmost cunning, and finally marked them down as they took their place on the nest. Thus many of Nature's most closely guarded secrets can be followed to the last detail, to say nothing of the constant arguments and "scraps" which take place among the more quarrelsome—such as the coots. With the naked eye the birds would probably be invisible, or at any rate could not be identified with any degree of accuracy, and observation of such shy birds as the water rail is impossible without good glasses.

Binoculars, however, are often useful for the shortest ranges, especially where small birds are concerned. For example, a small bird busily at work in the garden may be suspected of being in mischief of some kind, but by focusing the glasses upon it one sees exactly what it is doing, even to the movements of the beak and the toes. It may then be discovered that he is at work hunting for some noxious insect or the larvae thereof, and such a discovery may prove of considerable value to gardening interests.

The Art of Stalking.

A great many bird photographers use hides—which they erect to contain themselves and the camera—adjacent to the haunts of the wild subject, but this is not always possible, or may be inadvisable. Generally speaking one must wait till incubation is far on, or the old bird may forsake on perceiving the strange object so near her nest. The best way is to erect the hide by degrees, so that it stands completed a day or two before it is used, but time does not always permit this. Personally I prefer to fix the camera (using a quarter plate, which is small to hide) in a camouflaged box near the point at which the bird is expected to appear. The focus is carefully fixed, and everything ready, one goes right away to a place where a keen watch can be kept through the glasses. It may mean a wait of some hours, for birds and animals have a way of approaching from the side least expected, or of deliberately standing with their



1. MALE WINCHAT
2. CURLEW
3. GOLDEN PLOVER
4. WOOD LARK
5. YOUNG NIGHTJAR;
6. PEREGINE TIERCEL WITH RABBIT
7. SHAG DRYING OUT
8. SHAG FEEDING ITS YOUNG
9. WEASEL.

*

backs to the lens, but eventually the photograph is taken electrically through a length of wire connected to the camera. Another way is to place the contact-maker in such a position that the bird or beast will take its own photograph on entering the sharpest focus, but one wastes a good many plates in this way owing to rapid movement, lack of light, or unsuitable pose. Of course, the disadvantage of both methods, as compared with the hide, is that one can expose only one plate at a time, instead of a dozen or so, without disturbing the wild subject. Also one must work at very high speed. One photograph I took of a wild weasel was useless because the animal had both eyes closed, and appeared to be dead. Evidently the exposure (1/800th sec.) caught it in the act of blinking—a result for which one might have striven a lifetime had it been desirable. In any case, the blink of a weasel will not occupy much time—probably 1/500th sec.—so there was not much margin before and after.

From these brief notes, haphazard as they are, I hope to have made clear that the possession of a good pair of binoculars affords a hobby as distinct as photography or micrology. For sportsmen—though their use may be limited to days out of season—and naturalist they are essential, while anyone interested in outdoor life will find that interest quite doubled by the possession of a good pair of binoculars, and by learning to use them. This interest begins straightaway, but it increases as one learns to adapt one's eyes to the use of the lenses and as one learns to pick up objects clearly and quickly.

As regards the selection of glasses, I have only one word of advice to give. There are on the market many foreign makes which are inviting on account of their low price, but to buy cheap binoculars of unknown make is very false economy. They rarely give satisfaction, and in a short time are valueless, and money is spent on a better pair. A good set of binoculars will last a century, and considering the satisfaction obtained from them, the initial cost is not really heavy. The Ross lenses, both for cameras and binoculars, have always served me well, but there are other good makes, and by sticking to any one of the well-known makers one is not likely to go far wrong.

Whaling in the Southern Ocean

By R. N. Rudmose Brown, D.Sc.

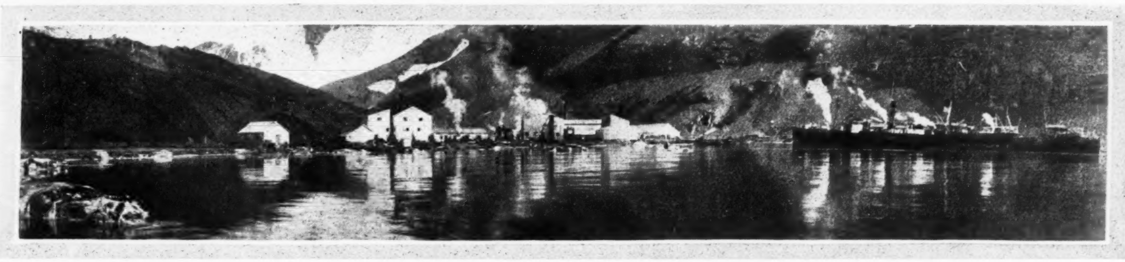
The whale, in spite of its size and its old association with the commercial needs of man, still presents many mysteries. Zoologists are concerned lest these animals should be exterminated and a considerable amount of scientific attention is now being focussed on the practice of whale hunting.

THE sailing of the *Discovery* for the Falkland Islands next September to investigate problems connected with whale fisheries, calls attention to a little-known but flourishing industry in the waters of that small and remote British colony. Whaling of old was a far more widespread occupation than it is to-day; whales used to be more numerous and, before the discovery of various vegetable fats, formed the principal source of heavy oils. Sperm oil was also in great demand for illuminating before coal gas and mineral oil were used.

In the Arctic seas whalers were at work around Spitsbergen over 200 years ago, and the Greenland Sea, Davis Strait and Baffin's Bay for many years proved lucrative hunting-fields to Scottish and English whalers. Arctic whaling is now confined to Bering Strait and Beaufort Sea, and the seas round Iceland and the Faroes. Sperm whaling in tropical waters of the Atlantic and Pacific was for long a most profitable occupation, and wandering whale-ships were among the first vessels to visit remote islands and far-away corners of the oceans. In the Southern Ocean whaling is not a new industry, but its concern with finners is a new development. The Falklands in the eighteenth century and the lonely island of Kerguelen in the nineteenth century were the resort of many whale-ships. In those days the only species hunted in the south were the sperm or cachalot and the southern "right whale" or bowhead. Finner whales were left alone, since their speed and quick movements forbade hunting with hand harpoons. Sir J. C. Ross in 1843 and the Dundee and Norwegian whalers in 1892-3, the latter on a cruise in search of right whales, reported many finners in South Atlantic waters. "Whale backs and blasts were seen at close intervals quite near to the ship and from horizon to horizon," wrote Dr. W. S. Bruce, naturalist on the *Balaena*.*

But the Scottish vessels were not equipped for that kind of whaling; as Mr. W. G. Burn Murdoch, who also accompanied the *Balaena*, put it, "we might as

*"Some observations on Antarctic cetacca." *Sec. Res. Scot. Nat. Ant. Exped.* IV. Pt. 22.



WHALING STATION AND FACTORY AT LEITH HARBOUR, STROMNESS BAY, SOUTH GEORGIA
Belonging to Messrs. Salvesens, of Leith.

well have tried a dry-fly for the Scottish express." The reports of the Dundee whalers failed to evoke enthusiasm in commercial circles in Britain, and it was left to the Norwegians to start finner hunting in South Atlantic waters, using explosive harpoons fired from steam whalers. The industry begun in 1904 has progressed at a phenomenal rate. In the year 1915-16 as many as 11,792 whales were captured in the waters of the Falklands Islands dependencies; latterly the number has fallen off a little, but was practically 7,000 in 1921-22. This decrease may be partly due to overhunting and consequent reduction in number of whales, but it is mainly attributed to fewer whalers being at work. The yield of oil per whale reached an average of 86 barrels in 1923-24. That is equivalent to about 14½ tons of oil per whale. Whale oil, which before the war was worth about £20 a ton, rose to £90 in 1920, and last year had fallen to about £30.

Kinds of Whales.

The modern industry in these waters started with an Argentine company at South Georgia. Since then Norwegian and British companies have also used that island as a base. There are now five land stations. At the South Shetlands whaling began in 1905-6. The crater harbour of Deception Island forms an ideal base, but floating factories are chiefly used and on account of ice are withdrawn in winter. As many as ten companies have hunted in those waters including Bransfield and Belgica Straits. In South Orkney waters pack-ice frequently interferes with the whalers, and the industry has been intermittent. Whalers first used these islands as a base in 1912-13, but since 1914-15 seem to have deserted them. In 1912-13 six licences were granted for the South Sandwich Islands, but they were not worked. The lack of harbours in exceptionally stormy waters makes whaling very difficult around that little-known group. At the Falkland Islands there was a whaling station at New Island from 1908 till 1916, when it was moved to South Georgia.† While in far southern waters ice restricts the hunting season to the period between the end of November and the middle of April, there used to be no limits around South Georgia even if the boisterous weather of the winter months was a great hindrance. But now the season is limited to the period from September 16 to May 31. During the winter the migratory population, which is chiefly Norwegian, return to Europe with the carrying steamers and floating factories, while the whale catchers are laid up, as a rule, in South American ports.

The whales hunted in these waters belong chiefly to three species: the humpback (*Megaptera nodosa*); the fin whale (*Balaenoptera physalus*); and the blue whale (*Balaenoptera musculus*). In smaller numbers are found the southern right whale (*Balaena australis*) and the sperm whale (*Physeter catodon*). The seihval (*Balaenoptera borealis*) is not of much importance south of the Falklands. Certain other species occur but so far have not attracted the whalers. The blue whale is the largest species, and may reach 100 feet in length; the fin whale is 50 to 70 feet long; the humpback 40 to 50 and the seihval 25 to 40 feet. The humpback used to be the chief whale caught: in 1910-11 it accounted for 96.8 per cent of the total catch of the three chief species, while in 1913-14 the percentage had dropped to 18.6 and in 1916-17 to 9.3. A comparable reduction in the number of humpbacks has been noted in whaling on the African coast. Excessive hunting would appear to supply the explanation, since the humpback is the easiest finner to catch as it comes closer to land than other species. On the other hand, the blue and fin whales are far richer prizes in their yield of oil and so are more eagerly hunted nowadays. Also it must be noted that improvement in hunting gear makes it relatively easy to tackle the bigger whales, which of course means the neglect of the smaller ones. It has been said (and also denied)

† This station belongs to Messrs. Chr. Salvesen & Co., Leith, to whom the writer is indebted for the photograph which accompanies this article.

that the decreased numbers of humpbacks in the whaling grounds is due to this relatively timid animal having been scared away to remoter seas, but this will not save the species unless it shelters among the pack-ice which is the sole sanctuary the whalers cannot penetrate.

There is no strong evidence that most species of finners are decreasing in numbers, but when the fate of other whale fisheries is borne in mind, the likelihood of extermination of these southern species is considerable. The Nordkaper or Atlantic right whale was nearly exterminated in Biscayan waters in the sixteenth century, and the Greenland or Arctic right whale has almost disappeared in the Greenland Sea and Baffin's Bay. This destruction was due to far less efficient weapons than those the modern whaler has at his command.

Whale Products.

Modern whaling is pursued mainly for the sake of whale oil which is obtained by boiling (" cooking ") the blubber, but whale meat, baleen or whalebone and guano are by-products. Whale oil is used for soapmaking and lubricating, and is suitable for human consumption in margarine. During the war it was in great demand for the manufacture of glycerine. It is a soft oil and has to be hydrogenated before being used for soap. The result is a white, odourless, hard fat, which for soap manufacture may be regarded as a tallow. It is of interest to note that the Hull whalers, who in the early seventeenth century pursued their calling in Spitsbergen waters, were largely responsible for the increased supply of good soap in those days. Sperm oil is obtained from the head and also the blubber of the cachalot, but the former source supplies the purest oil. A similar oil from the bottlenose has a smaller content of spermaceti. Sperm oil is used chiefly as a fine lubricant and at one time was in great demand for candle-making. Another important use of whale oil is in hardening steel.

Ambergris is a fatty disease product from the intestines of the sperm whale found occasionally floating on the sea in grey evil-smelling lumps. Strange to say, it is highly valued in perfume manufacture. Guano and meal are made from the dried muscle and bones. The meal is used for cattle feeding and guano forms a valuable fertilizer rich in phosphates. Whalebone or baleen is now largely replaced by steel in the dress and umbrella trades, but is still employed in the manufacture of brushes. For this purpose the short baleen of finner whales is quite suitable.

Whale meat is quite palatable but is little used, except in Japan, where it is in demand as an article of diet.

The investigations which the *Discovery* is to pursue (and are paid for entirely by the licence fees of the whales and export tax on oil), embrace problems relating to the feeding, migration, and breeding of whales. In view of the extent of the whaling in the waters of the Falkland dependencies, and now also of the Ross dependency of New Zealand, it is essential to know if measures should be taken to limit the industry in order to conserve the supply of whales. At present the industry is regulated by the granting of leases of land for shore stations and licences for floating factories and steam whalers. Certain regulations must be accepted with every licence granted. But in view of our ignorance of the habits of whales these regulations may be insufficient to protect the industry. In addition to man the only enemy of the whale is the killer or grampus (*Orcinus orca*). This ferocious creature is very common in the Southern Ocean and Antarctic waters. Contrary to the reported habits of the Arctic species of killer, the southern one moves readily among the pack. It lives mainly on fish and seals, but certainly destroys young humpbacks and no doubt other young whales. A case is recorded of a grampus attacking and killing an adult fin whale. In the north the Scottish whalers used to regard it as an enemy of the Greenland or right whale. Probably it attacks other species, but as they did not interest the whalers the occurrence was unnoted. If it was desirable to reduce the number of killers they would yield some oil in return for the trouble, but the hunt would be relatively expensive as this species is only some 25 to 30 feet in length.

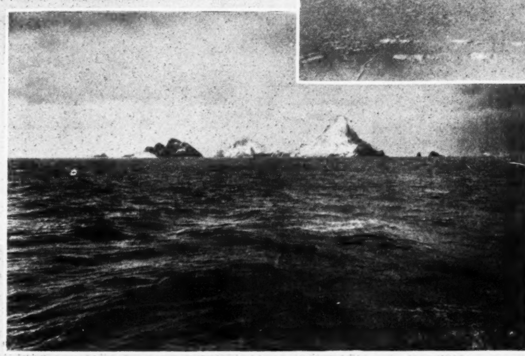
Problems.

Whale food consists largely of plankton organisms, the distribution of which is determined by currents and varying salinities of surface waters. By a study of the distribution of whales' food whose nature can be discovered by an examination of the contents of the whale's stomach, light will probably be thrown on seasonal migration. Captain Larsen, than whom there was no higher authority on whaling, says that the chief food of the humpback and fin whale is "krill," a whalers' name for various small crustaceans, but fish is also eaten. The blue whale feeds on " krill " only, while the sperm whale enjoys cuttlefish but " eats anything which the vast deeps have to offer."

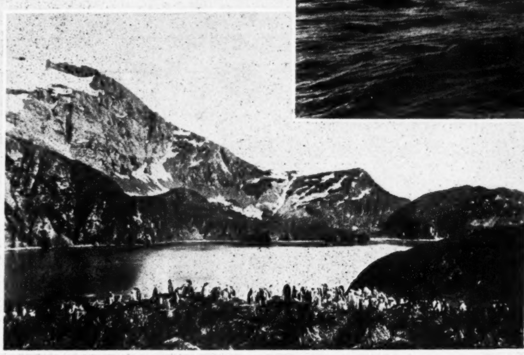
Accurate information with regard to the distribution of whales outside the whaling ground is difficult to obtain. To one who is not an expert the sight of a whale's head or back does not reveal its species, but to the expert even the " blast " of a whale is recognizable. A few Antarctic expeditions afford valuable records. In the Weddell Sea, Dr. W. S. Bruce (*loc. cit.*)

noted blue and fin whales as far south as lat. 72° S. in open water, but only bottlenose and killers or grampus among the pack. In the Ross Sea blue and fin whales and humpbacks are numerous as far as lat. 78° S., and all species have been noted in the pack. The southern right whale does not appear to enter the pack, and the sperm whale is not really an Antarctic species, although it is seen from time to time near the ice. The whalers contend that a season of much ice means plenty of whales, and vice versa. From a comparison of records this appears to be true. In any case, there is considerable variation in the number of whales seen in different years.

Evidence regarding migration routes may be obtained by marking whales. The research vessel could fire small numbered darts into the bodies of living whales which would be recovered when the whalers killed the animal. This method was tried by Dr. J. Hjort in Avebec waters last summer. The discovery of old harpoons embedded in the body, not a very unusual



SADDLE ISLANDS, SOUTH ORKNEYS.

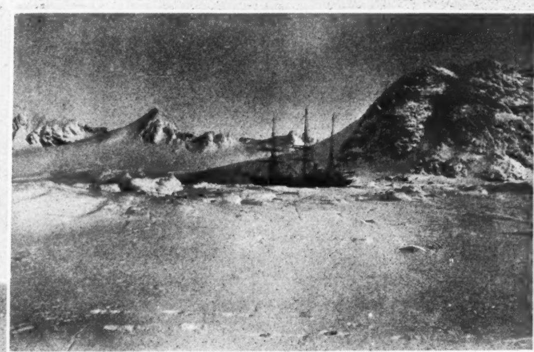


PENGUIN COLONY, SOUTH GEORGIA.

occurrence, also gives valuable evidence. It seems fairly certain that southern whales move equatorwards during the southern winter. The evidence is clearest with respect to the humpback.

But the most important problem of all concerns the breeding of whales. On this subject little is known. Whalers believe that the fin and blue whales have no definite pairing season, but that the humpbacks pair about September. As to frequency of pairing there is no evidence, but embryos are found in a large proportion of the whale-cows taken at South Georgia, and are not unlikely to be overlooked in others. The period of gestation is supposed to be about twelve months, but this is by no means certain.

These investigations must necessarily occupy some years, for the problems are many and work will be much hampered by frequent bad weather. Research work in a small vessel in the Southern Ocean is no



THE "SCOTIA" IN WINTER QUARTERS, SOUTH ORKNEYS.

child's-play. It would be difficult to find more arduous conditions. But if whale products continue in great demand it is certain that some measures must speedily be taken to limit the extent of whaling and, if necessary, to institute close seasons or provide whale sanctuaries in certain seas.

BIBLIOGRAPHICAL NOTE.

The subject may be studied further in *Report of the Interdepartmental Committee on Research and Development in the Dependencies of the Falkland Islands*, H.M. Stationery Office, 1920, Cmd. 657, and in Burn Murdoch's *Modern Whaling and Bear Hunting*, 1917, Rudmose Brown's *A Naturalist at the Poles*, 1923, and C. B. Hawes' *Whaling*, 1924. The last-named book, deals chiefly with the now extinct American whaling.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

THE Lord President of the Council has appointed Professor G. T. Morgan, O.B.E., D.Sc., F.R.S., F.I.C., Professor of Chemistry in the University of Birmingham to be superintendent of the new Chemical Research Laboratory of the Department of Scientific and Industrial Research at Teddington.

The Present Paths of Progress along which Photography is Struggling.

By T. Thorne Baker.

What is the secret of the photographic plate? Even the ordinary photographic plate still holds mysteries which the ablest chemists and physicists have not been able to solve. The future of photography depends perhaps not only on the optical efficiency of lenses but even more on the possibility of new discoveries in connection with the emulsion of the plates.

WHEN we read how Professor Boys obtained photographs of rifle bullets in motion with an exposure of a millionth of a second, we may well wonder why the chemist is struggling to make yet more sensitive plates and the lens-maker to produce yet "faster" lenses. Whither is photography leading?—for surely the most accurately timed shutter cannot be regulated to work very much faster than the 1,000th or 2,000th of a second which it will give to-day.

In all photography, however, we have to bear in mind that the *exposure* of a plate is measured by the product I.T., where I is the light intensity and T the time, and that over a fair range of variation in total exposure the density obtained in the negative is proportional to I.T. There is a minimum value of I.T below which the plate will not respond to light; the exposure will not give a developable effect; the actual minimum of exposure required to produce an image is expressed as the threshold value or *schellenwerth.*

Astro-physics.

This minimum value can be easily too low for the plates of to-day. Take the case of the astronomer by way of example. Present-day plates enable him to obtain photographs of stars of a certain magnitude; with present time-exposures fainter stars cannot be registered on the plate because their feeble light is not sufficient to overcome its inertia: it has not reached the threshold value. Here then is one very real need for still faster plates—to open up yet new worlds of celestial bodies which the human eye will never be able to see with the telescope unaided by photography. There are, in fact, innumerable instances where shorter exposures and faster plates would be of service to science, but our present aim is to discuss the lines along which these desiderata are being approached.

The sensitive film must be regarded from two points of view. It may be made, in its present state, faster and faster, or it may be made sensitive to a wider range of light rays. The ordinary plate is sensitive chiefly to rays ranging from the green, with a wave-length of about 5,200 A.U., to the ultra-violet about 3,600 A.U., and we therefore only use a portion of the possible light energy of the spectrum of white light in exposing it. It is true that, by using quartz lenses, we could utilize the ultra-violet rays usefully up to about 2,500 A.U., but the ordinary lenses of practice are opaque to them, as we shall see later on.

Let us take the ideal spectrum which can be obtained with a concave diffraction grating, in which every "colour" occupies a space strictly proportional to its wave-length. Roughly speaking, the violet, blue and green rays to which an ordinary plate is sensitive, (4,000 to 5,200) would occupy a space equal to about two-thirds that occupied by the greenish yellow orange and red rays, (5,200 to 7,000). Suppose then, that a panchromatic plate, sensitive to the whole spectrum, be tested against an ordinary plate sensitive only to two-fifths of the spectrum—will the former be two-and-a-half times as fast?

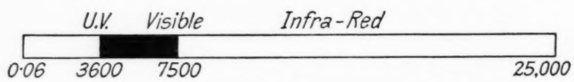


Fig. 1.—The white strip represents the range of "wave-lengths" to which silver bromide can be made sensitive. The small black portion represents the small band actually used when making a camera exposure.

The answer is Yes, if we exclude the ultra-violet from our calculation and use a plate absolutely evenly sensitive to the whole visible spectrum. But in practice, an exposure in the camera to daylight entails the use of the ultra-violet rays in both cases, and the panchromatic plate will only be markedly faster if a light filter be used in both cases—filtering out the ultra-violet and diminishing the blue-violet, to which all plates are abnormally sensitive, whether panchromatic or not.

For spectroscopic photographic work, the panchromatic plate is of course an immense advantage, and the excellent plates of this kind manufactured during the last few years have been of the greatest possible value in colour measurement and spectrum work.

Plates can be made which record the infra-red rays up to a wave-length as great as 25,000 A.U. We know also that they will record the shortest rays of wave-length 0.06 A.U. An ideal plate might thus be produced to respond to the enormous spectrum represented in Fig. 1, whereas in ordinary photography we make use only of the small portion represented by the blackened strip. At most, with ultra-violet transparent lenses and panchromatic plates, we could use the region lying between about 7,000 and 2,200 A.U.,

Fig. 2.—The spectrum photographed on an ordinary plate. Compare with Fig. 3.

for the gelatine essential in the manufacture of a fast plate precludes by absorption the use of ultra-violet beyond this point. The difference between an ordinary and a panchromatic plate in behaviour to the visible spectrum is seen in Figs. 2 and 3.

Emulsion Mysteries.

The line along which chemical research is proceeding at present is to deal only with the shorter range, but to increase the sensitivity of the plate to this range. What is the secret of sensitiveness of the silver salts ?

The starting-point in a sensitive emulsion is to mix silver nitrate with a gelatinous solution of ammonium bromide ; the precipitate of silver bromide is produced in the form of minute grains or clumps of grains of the silver salt, each of which is "clothed" with gelatine ; this emulsion—really a suspension of silver bromide in gelatine—is excessively insensitive, even though a considerable amount of ammonia be used, as is the case where a rapid emulsion is ultimately required. But a process of "digestion" of the emulsion, at a temperature of something over 35 deg. Centigrade, causes the crystalline grains of silver bromide to grow in size and simultaneously to gain increased sensitivity.

The emulsion, as is well known, is set until jellified, and the jelly is broken up into shreds which are washed with water until the free ammonia and the deliquescent ammonium nitrate by-product is removed. The washed shreds, if remelted and again warmed, again increase in sensitivity until a maximum is reached. The reason for this maximum limit we do not altogether understand.

We do not, indeed, understand why the silver bromide becomes more sensitive to light as the crystal grains increase in size or are submitted to the warm digestion. When the secret is discovered, it may be possible to push the process and obtain plates a hundred times more sensitive than the fastest plates manufactured to-day. We may, on the other hand, have already obtained, by more or less empirical methods, as great speed as can be got with silver bromide. We must not forget that salts of thallium, uranium, chromium, mercury, iron and many other elements, are sensitive to light ; that crystalline silver sulphide, (as Geiger has recently found), produces electricity under the influence of light, and that by such a phenomenon some entirely new photographic process may be evolved.

That the speed of a plate depends solely upon the size to which the grains or crystals grow is now fully disproved. It is evident that some chemical action takes place alongside of the physical modification, and it seems fairly certain that the extreme instability in light of highly sensitive silver bromide is largely due to the presence of "impurities," without which great rapidity cannot be obtained. Not only the sensitivity of the grains but even their spectral absorption can be modified by the absorption of, or interaction with, very minute traces of inorganic matter.

Some attention is being focused just now upon the hypothesis of Fajans and Frankenburger, who think that in sensitizing silver bromide crystals we cause them to adsorb hydroxyl ions, and that their sensitiveness is more or less a function of the number of hydroxyl ions adsorbed per unit of surface. Such theories are being widely investigated, and must ultimately pave the way to yet faster plates than can be made at present.

Quartz Lenses.

There is another direction in which more rapid photography is being sought, and that is by the use of lenses of bigger aperture and greater transparency

Fig. 3.—The spectrum photographed on a panchromatic plate.

to light of photo-actinic wave-length. If the spectrum be photographed with ordinary lenses and prisms we get the result (on an ordinary commercial plate) seen in Fig. 4, whereas with quartz lenses and prisms we get the result seen in Fig. 5. These spectrograms were made with the same exposure and development in each case, Fig. 4 with a commercial R.R. lens intercepting the beam of light from an aluminium spark, Fig. 5 with a quartz lens in place of the R.R.

Fig. 4.

Fig. 5.

The top line represents the spectrum obtained with ordinary lenses, the lower one that obtained when quartz lenses are used

lens. With the latter, it is seen that rays up to a wave-length of 2,400 A.U. act on the plate, and it is not surprising to learn that by using a quartz lens in the camera we need only give *one-fifth* of the exposure required with ordinary lenses !

The difficulty in the way of a practical application is that the manufacture of an achromatic quartz lens presents grave difficulties to the computer ; it can be done by using a second lens of rock salt, but not—so far—with an ordinary commercial glass. The extraordinary transparency of fused quartz has been recently determined, and if we could find a substance of suitable refractive index to correct quartz for chromatic aberration, the rapidity of photographic exposures might be enormously increased. The problem is, unfortunately, obviously paradoxical.

We have, on the other hand, exquisite lenses of British manufacture working, with first-class definition, at the very big aperture of F/2.9 and even F/2.1, and in this way the speed of modern photography has been substantially increased. Using a lens at F/2.25 (the working aperture$=\frac{4}{9}$ of the focal length) the exposure can be reduced to a quarter of that required with a lens working at F/4.5 ; the latter was until recently considered the lens *de luxe*, but modern cinematography and portraiture have made fresh demands upon the lens-maker's ingenuity.

More rapid photography thus depends upon either the successful inquiry by the plate chemist into the means of increasing the speed of his emulsions, or the successful research of the optician to use materials of greater transparency to light, and embracing a wider range of wave-lengths in the manufacture of his lenses. In the latter case the plate chemist is still faced with the problem of producing plates more sensitive than at present to the ultra-violet rays which will be transmitted by the corrected quartz lens, which is at present the subject of investigation.

Insulin Up to Date.

By A. S. Wilson Jones, B.Sc.

In five years insulin has developed from a laboratory novelty to an important medical product. The life of patients depends on a regular supply. To-day scientists are finding that insulin can be made not only from the pancreas but from other organs as well.

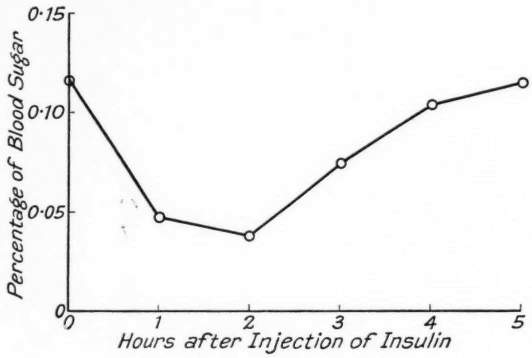
INSULIN, now known as a cure for diabetes, is very much talked about, but no one knows what it is. We know what it does but that is not the same thing as knowing what it is. We know what electricity does, but we do not know what it really is. That does not prevent us making very good use of it. What insulin does is to break down the sugar in the blood and allow the body to make use of it. In the normal person the supply of insulin comes from certain cells in the pancreas, known as the Islets of Langerhans. In the disease known as diabetes the natural supply of insulin is either deficient or absent altogether. The result is that sugar accumulates in the blood and can only be removed through the kidneys. The kidneys are not designed for this, consequently, everything is thrown out of gear.

Diabetes in an advanced stage brings great weakness, a state of coma and eventually death. The effects can be very much reduced, however, by cutting out all sugar in the diet. This, of course, is very troublesome for the patient, and, besides, cuts out a very important energy-producing food. All starchy food must also be excluded because starch is converted to sugar in the digestive processes.

There have been many attempts to obtain the insulin from the pancreas. Until four years ago these attempts all failed. Although many pancreatic extracts were prepared, none of them were any good in cases of diabetes. The reason for this was that insulin is a very delicate substance, and it was decomposed by the substances obtained from the other cells in the pancreas soon after the extraction was

started. In 1920, however, Dr. F. G. Banting, a Canadian physiologist, managed to obtain some insulin, by a method which he perfected in the laboratories at Toronto University.*

The process for making insulin is entirely a chemical one, and there seem to be good reasons for supposing it is a chemical substance. But there is no ordinary way of testing it chemically. There is only one way



Graph showing the effect of insulin, on the sugar content of the blood of a normal rabbit.

of discovering whether a sample which has been prepared is properly active, and that is to see if it will cause the disappearance of sugar from the blood. For this purpose a rabbit is used. In order that the percentage of sugar in the blood may reach some standard value the rabbit has first to be starved for twenty-four hours. A sample of its blood is then taken, an injection of insulin made, and after some hours another sample is taken (see diagram). If the percentage of sugar in the blood has dropped enough it shows that the sample of insulin is up to standard. The rabbit, meanwhile, recovers its normal amount of sugar by having a good meal. If too much insulin is given the sugar in the blood falls too low, and convulsions may occur, but by injecting sugar solution the animal quickly recovers. It will be seen that the production of insulin on a commercial scale has meant the development of somewhat unusual methods of testing the product.

Therapeutic Effect.

This is only one of the smaller problems before the manufacturer of insulin. The process worked out by Dr. Banting is an extremely delicate one, and very expensive to carry out. Now insulin is not a cure for diabetes, in the sense that one or two doses will make the patient better. The insulin production in the body has failed, and artificial insulin has to be supplied in carefully regulated quantities to keep the percentage of sugar in the blood within normal limits. Sometimes this will allow the overstrained Islets of Langerhans to recover, but generally speaking insulin has to be administered regularly to keep the patient in normal health. Thus insulin is as necessary as food, and therefore it had to be made cheaply and in large quantities.

It is common knowledge among chemists that in carrying out a successful laboratory process on a larger scale all sorts of difficulties may arise, sometimes so great as to be insuperable. In less than two years' time, however, British firms with well-known names—succeeded in perfecting the mass-production of insulin. The cost was actually brought below that of the American manufacturers who started first. In 1922 insulin cost 25*s.* per hundred units, while early in 1924 the price was 2*s.* 8*d.* One of these firms is actually using three tons of ox and sheep pancreas every week for extracting the insulin.

Commercial Process.

Some idea of the complexity of the process that has to be followed in making insulin can be gained by noting the bare stages involved. Mr. F. H. Carr, one of the directors of the British Drug Houses, described the method very fully at a meeting of the Society of Chemical Industry in Liverpool.† The pancreas glands have first to be procured and dissected as soon after the death of the animal as possible. They are then cooled to a low temperature to prevent the insulin decomposing while the glands are minced and ground up. Insulin is then set free by adding either acid or alkali to obtain the exact degree of acidity which releases it. The insulin has then to be extracted by dissolving it in alcohol, which has to be of very precise strength (65-70 per cent.) so that the minimum of the other deleterious substances present is taken along with it. The extract is cloudy and has to be cleared by cooling below the freezing point (to 5°C.), and filtering or centrifugally separating the solids. The liquid is then evaporated down, at a low temperature under a vacuum, to one-tenth of its bulk. The fat is now extracted and filtered off. Various harmful proteins are then removed by precipitating with alcohol or ammonium sulphate, then again with alcohol and picric acid in turn, all the time keeping the degree of acidity carefully controlled. The insulin is then roughly separated but it has to be purified by several other stages before it is ready to be sent out.

* Trans Royal Soc., Canada. 1922. Vol. 16, p. 1.

† J. Soc. Chem. Ind., July 18, 1924. Vol. 43, p. 228 T.

*

Although the process appears involved it works very smoothly, and it is because of the perfection of this method that the price of insulin has been so much reduced. A German chemist who was recently in England said that our production of insulin was actually the most notable thing that the British chemical industry had done recently. The large developments in the dye and fine chemical industries since the war he rather discounted, because they are in the main copies of German methods, but to make a substance like insulin seemed to him to be something novel, and a much more telling indication of the vitality of chemistry in this country.

Fresh Sources.

Since the various plants making insulin have been going, something has been added to our knowledge of its nature. If insulin was a kind of magic it would seem that the recipe for the magic did not depend so much on taking particular materials, as observing a particular rite. No pancreatic extract was any use in diabetes until the right way of making it was found, and now the means has been perfected it has been found that it is not essential to start with the pancreas at all. Insulin has been obtained by starting with all sorts of unexpected organs of the body—lungs, liver, spleen, heart and skeletal muscle, kidney and various glands. Though possibly the substances obtained are not identical, they are all effective in reducing the amount of sugar in the blood, and would therefore be useful in curing diabetes. Some of the glands used have furnished large quantities of insulin, and the question now arises what its purpose there can be. Alternatively, it is suggested that it is not really present as such in the glands, but is produced from some other substances during the manufacturing process, i.e., the magic may be in the rite. These questions have yet to be answered.

From the practical point of view it must be remembered that insulin is not a cure for diabetes, because it does not remove the cause. Research may someday find a real cure, but it has done much in enabling diabetic patients to live normal and useful lives as citizens. The greatest effect is shown with children who had contracted diabetes and who have been saved by insulin, because in the young the disease was nearly always fatal. Sugar is so essential to the active and growing body that when it is deprived of it the starvation of the cells cannot be averted to the same extent that it can with older people by taking other foods.

Patients may guard against an overdose of insulin, which would lead to convulsions by eating sugar as soon as the symptoms set in. This has to be carefully watched but it is not an important drawback to the treatment.

Two notable cures which have been effected by insulin were cases of children—and, as has already been mentioned, a child who becomes diabetic suffers particularly severely. The first child had contracted the disease at four years of age, and its wasting effect was so great that at eight years she weighed only two stone and was almost unbelievably thin.‡ With insulin treatment she regained a normal appearance, and after six months she weighed three stone ten pounds, and was able to go to school daily. In the other instance a doctor's daughter, who was on the point of death, was saved in 1921 by insulin which had been made experimentally in this country before it became generally available. After a while no more could be obtained, and the child relapsed into a state of coma. The American-made insulin was then on the point of being "released" to the profession, but none could be obtained until the appointed date. In order that the child should have every possible chance she was brought to London so that she could have the insulin at the earliest possible moment, and her life was saved a second time. This time the supply was uninterrupted and she was able to regain normal health.

ZOOLOGICAL SOCIETY OF LONDON.

THE Meetings of the Society for Scientific Business will be resumed on TUESDAY, February 3rd, 1925, at half past Five o'clock P.M., when the following communications will be made:—

THE SECRETARY.—Report on the additions to the Society's Menagerie during the months of November and December, 1924.

G. C. ROBSON, M.A., F.Z.S.—Exhibition of a Giant Squid (*Stenoteuthis caroli*) recently stranded on the Yorkshire coast.

M. STERLING MACKINLAY, M.A. (Oxon.).—The Language of the Emotions: Universal Methods of Expression.

Dr. N. S. LUCAS, F.Z.S.—Ill-health in Captive Wild Animals and its Causes.

Prof. O. FUHRMANN, Ph.D., and JEAN G. BAER, D.Sc.—Zoological Results of the Third Tanganyika Expedition conducted by Dr. W. A. Cunnington, F.Z.S., 1904–1905.—Report on the Cestoda.

DORIS R. CROFTS, M.Sc., F.Z.S.—The Comparative Morphology of the Cæcal Gland (Rectal Gland) of Selachian Fishes.

STANLEY HIRST, F.Z.S.—Descriptions of New Acari, mainly parasitic on Rodents.

‡ J. Soc. Chem. Ind. July 18, 1924. p. 233T; and the Lancet.

British Marine Biological Laboratories and their Work.

By Marie V. Lebour, D.Sc., F.Z.S.
Naturalist at the Plymouth Marine Laboratory.

The harvest of the sea is an all-important matter to an island people. The practical applications of the scientific research work done at the various marine laboratories have far more to do with the conservation of food supply than is generally known.

THE British marine biological laboratory exists for the purpose of studying the sea in all its aspects, primarily however, to further everything to do with sea fisheries and ultimately to help them in every possible way. Thus the scope of the work is very wide for, in order to gain true knowledge of our fisheries an accurate idea of everything in the sea is necessary, from the sea itself, its chemical contents and all its physical features together with currents, winds and tides, to all the life in the sea, the fishes themselves and other animals living with them, all of which are mutually interdependent. To investigate all these subjects and to bring such researches together in order that by so doing we may discover in what way and to what extent they affect our fisheries is the prime object of a marine laboratory.

Photo by] [E. A. Pleasance
THE PLYMOUTH MARINE LABORATORY.
From the Hoe.

" It has been said that the science of oceanography was born at sea on 15th February, 1873, at the first official dredging of the Challenger Expedition," thus says the late Sir William Herdman in his delightful book " The Founders of Oceanography." It is certain that this great expedition was the stimulus to the furthering of true oceanographical research, and the need for more marine laboratories in which such research could be carried out was felt.

It was a year before this that the celebrated Marine Biological Station at Naples was founded by Dr. Anton Dohrn of ever famous memory, whose son is now, after some years absence, once again the director. This station was, and perhaps is still, the best known of all the marine laboratories of the world.

In Great Britain, Scotland has the honour of starting the first marine laboratory. In 1883 the Scottish Fishery Board, to help them in their fisheries work carried on all round the coast, fitted up a small laboratory at St. Andrews, and here much research work was effectively carried on until in later years it was transferred to Aberdeen, which is now the headquarters of the Scottish Fishery Board. The official marine laboratory of the English Board of Agriculture and Fisheries is at Lowestoft. In these government laboratories which have their own trained staffs and research steamers, much work specially and directly appertaining to the fishery industry is continually going on, throwing much light on the many points investigated. For example, the question of the destruction of immature fishes and the successful transplantation of small plaice from shallow water near the coast where there is comparatively little suitable food to such rich feeding places as the Dogger Bank, where they grow quickly and soon reach a size suitable for the market. Also detailed investigation into the age of fishes as told chiefly from their scales and otoliths (small limy concretions in the ear capsules), both of which show by distinct rings the periods of growth and thus the ages of the fishes. Applying these methods to the study of our edible fishes much has been discovered with regard to their larger fluctuations and migrations.

The Millport Laboratory.

It is left for the independent marine laboratories which do not belong to the Government to investigate those problems which are fundamental and yet not of such immediate practical importance. On these general fundamental problems all the practical fisheries work depends and, although by no means restricting their work, this is the main tendency of the laboratories at Plymouth ; Millport in the Clyde ; Cullercoats, Northumberland ; Port Erin, Isle of Man ; Piel on the Lancashire coast ; and at St. Andrews. The last named, the Gatty Marine Laboratory, is unfortunately not at present in use owing to lack of funds.

In 1884 a small laboratory was established at Granton, on the Firth of Forth, near Edinburgh, in an old quarry under the auspices of the Scottish Meteorological Society. Here investigations were begun on the habits of economic fishes, especially the herring. The laboratory itself was a floating

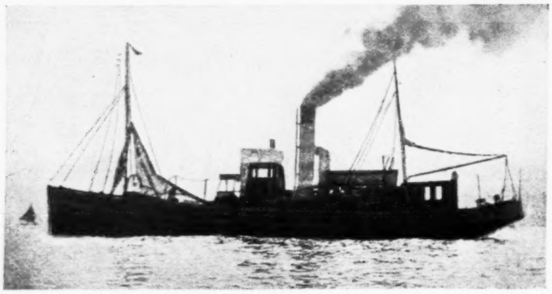


Photo by] [*S. M. Nunn*
THE "SALPHA" RESEARCH STEAMER OF THE PLYMOUTH MARINE LABORATORY.

one made out of an old boat and named the "Ark." Later on the "Ark" was transferred to Millport on the Island of Cumbrae on the Clyde, and there its name is remembered in association with the Scottish naturalist David Robertson, "The Naturalist of Cumbrae." After the "Ark" was dismantled, the Millport Marine Biological Station was built which, although chiefly a research station with an aquarium, includes a museum to house the Robertson collections. The station is now the laboratory of the Scottish Marine Biological Association, and is equipped with a research staff which, aided by a motor-launch, is actively engaged in an intensive study of the rich fauna and flora of the Clyde. Much of this work has to do with the herring, its migrations and its food.

The Plymouth Laboratory.

In 1884, when the "Ark" was still at Granton, the Marine Biological Association of the United Kingdom was formed with the object of founding an adequate marine laboratory on the British coast; Plymouth was selected as the site of the laboratory which was in working condition in 1887. This laboratory the largest in our country, possesses an excellent aquarium where local marine fishes and invertebrates are seen to their full advantage, and a large working laboratory above provided with experimental tanks and accommodation for numerous workers. Besides the main laboratory, aquarium, library and residential buildings for the director and caretaker, the "Allen Wing" was built in 1922 which includes a working museum and fisheries laboratory. A physiological department in the main building was added at the same time. The laboratory possesses a research steamer and other smaller boats which collect the research material, and cruises for the purposes of hydrographical and biological work are undertaken periodically. There is a permanent staff consisting of director, physiologists, naturalists, hydrographer and other assistants.

The main object of the research work at Plymouth is the elucidation of the biology of all marine animals, including the life histories and distribution of fishes, especially those of economic importance. The spawning habits and migrations of these fishes are also specially studied, their food and the life histories of those organisms that constitute their food directly or indirectly, the biology of edible mollusks and other shellfish, the composition of sea-watei and its chemical and physical fluctuations together with the study

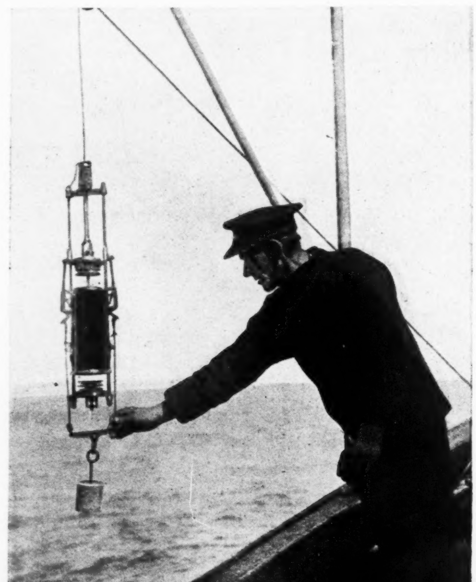


Photo by] [*Dr. J. Dunkerley*
HAULING IN THE WATER-BOTTLE.
On board the Plymouth Research Steamer "Salpha."

of currents throughout the year. Amongst these subjects the study of plankton or the floating life of the sea, both animal and vegetable, is of special importance, as here is to be found the minute unicellular plants on which ultimately the whole life in the sea depends. Feeding like typical green plants

it is essential for them to be in those upper layers of water where sunlight can penetrate, so that by means of their chlorophyll or some closely related substance they can split up the carbon dioxide dissolved in the water. "The meadows of the sea" is the name given to these small plants collectively, which are all unicellular and made up chiefly of diatoms with siliceous shells together with a lesser number of various other groups. Floating in the sea is an enormous number of small creatures all preying upon each other, the diatom serving as food for most of these, which in their turn are eaten by the larger animals and so on in endless succession.

Researches on the culture of these marine diatoms by the director, Dr. E. J. Allen, are of very great significance. By extremely careful and accurate experiments he was successful in ascertaining the exact conditions for making pure cultures, and was thus enabled to rear diatoms for feeding. The principal diatom now employed in this way is a small species belonging to the genus Nitzschia. It is extremely interesting that in recent researches in London, Professor Drummond of University College and his colleagues have demonstrated the presence in this same diatom of Vitamin A, which is such an important constituent of cod-liver oil.

The Food of Fish.

Many small planktonic crustacea known as copepods naturally feed on this diatom, and young cod feed on copepods, so it is highly probable that the vitamin enters the body of the fish originally from the diatom. In this connexion we may mention out of the many marine animals experimentally reared at Plymouth the successful rearing through its whole life history from egg to adult of one of our commonest copepods, *Calanus finmarchicus*, by Mr. L. R. Crawshay, which were entirely fed on these pure cultures of Nitzschia. Researches relating to the food of the minute fry of local fishes belonging to the cod family showed that copepods formed almost their entire diet for at any rate, the whole of their babyhood.

Almost all the important food fishes shed truly planktonic floating eggs, from which emerge young, also planktonic, for a certain time. Mr. R. S. Clark's researches on these baby fishes of Plymouth have thrown much light on their distribution and biology. Thus, with the spawning of the clupeoids, or herring family, it has been found that whilst the herring spawns close inshore (although its eggs fixed to objects on the sea bottom are not easy to collect), the sprat's floating eggs are abundant from close inshore to a few miles out over fairly shallow water, and those of the pilchard, also floating, are shed much further out to

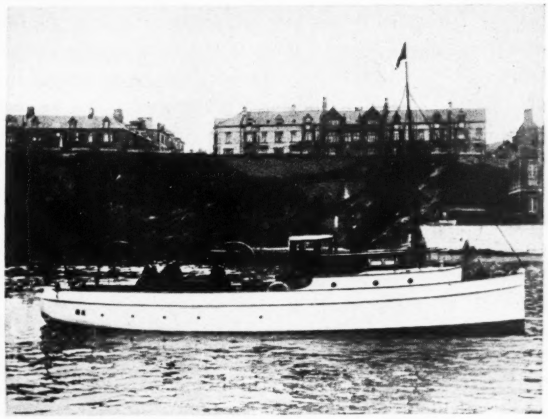


Photo by] [*B. Storrow.*

THE RESEARCH BOAT "EVADNE."
Dove Marine Laboratory, Cullercoats.

sea over much deeper water. It seems almost incredible that such a short time ago the eggs of the sprat and pilchard were unknown, for it is only since the Plymouth Laboratory was built that their life histories have been discovered, the researches of Dr. Cunningham bringing much new matter to light. It is, moreover, only within the last few years that it has been possible to distinguish between the very young stages of the herring, pilchard and sprat.

In direct connexion with the commercial side of the fisheries is the Flake Industry, the Plymouth Laboratory having been instrumental in successfully introducing dog-fish as a good food for human consumption. Disguised under the name of "Flake" it is a flourishing industry.

Dr. Orton's researches on oysters and the whole question of edible shellfish are of extreme interest, not only from the actual commercial side, but also from the general biological point of view. He has shown recently that the oysters, as well as other marine invertebrates, change their sex and that in the oyster this may occur so quickly that before the female has actually discharged her larvae, she has changed into a fertile male. Here the chemical side of the question is very much apparent, and it has been found that oysters may naturally contain a comparatively large amount of arsenic which is, however, not at all deleterious to the consumer. "Sound oysters," says Dr. Orton, "yielding the maximum of arsenic found, namely, five parts of arsenic in one million parts of oyster meat contain about three and a half times more arsenic than is allowed in food (1/100 grain in a lb.). It would, however, be necessary to eat more than two dozen of such oysters to take the minimum daily dose given in the British Pharmacopoeia."

The chemistry and physics of the sea is becoming more and more important as new knowledge arises. Not only do the large moving masses of water affect the migrations of fishes and have to be known thoroughly, but all the physical factors must be studied and the results brought to bear on each problem. Dr. Atkins' researches on the acidity and alkalinity of the sea throughout long periods and of the contained salts, especially the phosphates in relation to the green plants are of fundamental importance.

On the purely experimental side the work of Dr. Allen and Mrs. Sexton on Mendelian inheritance in amphipods or sand-hoppers is peculiarly significant and far-reaching, and is still being carried on with results which are ever increasingly interesting. So complicated have the experiments become that the broods occupy many hundreds of small glass receptacles in two special compartments, one of which is kept always at an even temperature. It has been found that the inheritance in eye colour in this small creature follows perfectly the law of Mendel, and Mrs. Sexton has discovered intersexes in the same animal, which are now being specially investigated. Space does not permit of more being said about the work of the Plymouth Laboratory, but enough has been touched upon to show the variety of work, all of which converge to the one important object—knowledge of the biology of the sea.

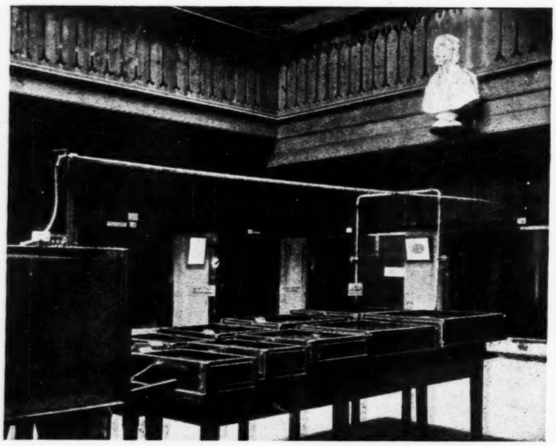


Photo by] [*T. R. Brunce*

THE AQUARIUM, PORT ERIN STATION.
Showing the bust of Edward Forbes.

The Port Erin Laboratory.

The building of the Plymouth Laboratory was followed by others. In 1892 the Liverpool Marine Biology Committee established a laboratory on the sea front at Port Erin, Isle of Man, having previously worked in a small one on Puffin Island, off the coast of Anglesey. Ten years later the new laboratory with aquarium and fish hatchery was erected at the south end of the Bay where the Government of the Island and the Liverpool Marine Biology Committee combine experimental fish hatching with the other scientific investigations. Here there is a large open-air spawning pond, where fishes are reared from the egg, chiefly plaice. Most of these plaice are transferred to the sea at a very early stage, but some are reared in indoor tanks, and it is possible to see in the aquarium three generations of these pond-reared fishes. It is well known that the plaice with its other flat-fish relations is hatched as a free-swimming larva with an eye on each side of its head, thus having the appearance of an ordinary "round" fish, such as the haddock or cod. As the little fish grows one eye gradually migrates towards the top of the head and so round to the other side, eventually the two eyes being on the same side. The fish then takes up its position on the sea bottom, lying on one side with both eyes uppermost. These interesting transition stages can all be well seen at Port Erin.

The name of Sir William Herdman will always be associated with this laboratory, for he not only encouraged and helped it on in every way but himself did much work there, especially in connexion with plankton researches at sea, and a very large amount of this kind of work has been done here. There is a charming little aquarium over which the bust of Edward Forbes, born at Douglas, Isle of Man, presides as an ever-present memorial of his many famous contributions to, and never failing interest in natural history. There are good working laboratories, both chemical and biological, and a scientific staff permanently carries on research of various kinds.

The laboratory at Piel on the Lancashire coast with a fish hatchery is the property of the Lancashire and Western Sea Fisheries Committee, which also has a laboratory in Liverpool University.

The Cullercoats Laboratory.

On the Northumberland coast at Cullercoats is the Dove Marine Laboratory. This belongs to Armstrong College, Newcastle-upon-Tyne, in the University of Durham. Some years before it was built, Professor Meek, the present director, established a small wooden building on the Cullercoats beach for the purpose of marine research. After much good work being done there this building was unfortunately burnt

down, and the Dove Marine Laboratory erected near its site. This was opened in 1908. It consists of an aquarium, tank room for experimental purposes, and research laboratories with a scientific staff attached. There is a motor-boat large enough to undertake cruises out to sea lasting for several days. Fish problems are the chief aim here, Mr. B. Storrow having made a speciality of the study of the herring, but many other important investigations are carried on, including those in connexion with river pollution, and Professor Meek's studies in crustacean shell-fish have led him to be instrumental in establishing a close season for the lobster during its breeding time, it now being illegal to take a " berried " lobster or one carrying eggs.

Facilities for Outside Workers.

In all these laboratories the independent scientific worker is welcome to carry on investigations of his own, and is provided with working room and material. In this way visitors from all countries have opportunities of meeting their fellow-workers and students from any University, or those with private hobbies can join a laboratory for a few days, weeks or months as they prefer and work at the subject in which they are interested. Easter or Summer vacation courses which are much enjoyed are held in most of them for students, special space being allotted to them and collecting excursions arranged on shore and at sea.

Methods of Collecting.

In order to collect the material for research, various methods are used. Hand collecting down to low tide on shore for the littoral animals living on rocks, under stones or in rock pools, digging in sand for burrowers. Hand nets for shrimps, prawns and small fishes. Out to sea the collecting boats are provided with nets of all kinds. For plankton, tow-nets are used. These are conical nets made of fine silk with a varying mesh, the wide mouth sewn on to a ring, the narrow end being provided with a cylindrical can. The net is towed slowly from a small boat or steamer, and catches in the can the small organisms floating in the sea. For the very minute creatures a water bottle may be used which is arranged to take samples of water at various known depths. The same kind of bottle may be used for water samples for chemical contents. The water may be centrifuged in order to examine the smallest organisms contained in it. For catching baby fishes a young fish trawl is used, the net made of a fine meshed material known as stramin, the mouth provided with boards, or the same net may be put on a ring so that it is like a large tow-net. This net is also towed from a steamer or small boat at various known depths, and catches larval and small post-larval fishes and other animals rather larger than those usually caught in the tow-nets. Tow-nets that are made to close at known depths are also used. Larger fishes are usually caught by the otter trawl and other special trawls. The dredge, besides fishes, brings up various invertebrates, crabs, mollusks, etc., and the " grab " takes up bodily a sample a square foot or two in area of the sea bottom for the purpose of studying faunal relationships. Various nets similar to those used by the fishermen are used for certain purposes, including seine nets for fishing near the shore. For the study of currents " drift bottles " are set free in the sea. Each bottle, the size and shape of a ordinary soda-water bottle, is sealed and weighted carefully either to float just below the surface or at the bottom, and inside is placed a card on which is written in several languages a request that the finder break the bottle and send the card, noting the place where picked up, to the address given. Thus the place where the bottle was put into the sea and the place where it was picked up being known, the direction of the current which carried it is known.

Various pieces of apparatus too numerous to mention may be used and samples of the sea itself and of its inhabitants may be brought to the marine laboratory, there to be thoroughly investigated by the worker, and thus problem after problem may be solved and a first-hand knowledge obtained of everything to do with the sea.

The number of marine laboratories is steadily growing all over the world. They are to be found in large cities and in lonely tropical islands. It is now realized that they are necessaries and not luxuries, and that the great science of oceanography cannot do without them.

SOCIETY OF PUBLIC ANALYSTS

AND OTHER ANALYTICAL CHEMISTS.

THE Annual General Meeting of the Society will be held on Wednesday, 4th February, at the Chemical Society's Rooms, Burlington House, Piccadilly, W., at 8 p.m.

The Accounts for the year will be presented, the President will deliver his Annual Address, and the Election of Officers and Council for the ensuing term will take place. The appointment of Auditors will be made.

The Ordinary Monthly Meeting of the Society will be held immediately following the Annual General Meeting, when the following papers will be read :—

" Cinchonine as a Tannin Precipitant with Special Reference to the Analysis of Cutch and Gambier " By David Hooper, LL.D., F.I.C. (*Work carried out under the Analytical Investigation Scheme*).

" The Examination of Charred Documents." By C. Ainsworth Mitchell, M.A., F.I.C.

" The Absorption of Carbon Monoxide in Gas Analysis." By H. R. Ambler, B.Sc., A.I.C.

INFORMAL DINNER.—Arrangements have been made for Members and their friends to dine together at St. James' Restaurant, 178 Piccadilly (opposite Burlington House), at 6.30 p.m.

Tea and coffee will be served in the Library at 10 p.m.

Soil Bacteria and Cellulose.

By P. H. H. Gray, M.A.

Rothamsted Experimental Station.

The growth of motor transport and the importation of frozen meat are both reducing the supplies of farmyard manure on which agriculturists depended. This has led scientists to study the production of synthetic manure made from cellulose by the action of bacteria. The process is one of the most important of recent discoveries in scientific agriculture.

MANY of the processes of Nature most valuable to mankind are due to the activity of micro-organisms that live in the soil. Without bacteria that can convert organic compounds of nitrogen into a form utilizable by the plant, our land would bear no crops. Similarly, poisonous substances such as phenol occur in small amounts in farmyard manure, and if it were not for the rapid action of bacteria, combined with a slow chemical process, the continued application of this substance to the soil would increase the amount of phenol to such an extent that plant life would soon be quite suppressed.

Cellulose.

In a previous article* the writer dealt with the group of micro-organisms whose beneficial work lay in removing poisonous compounds like phenol and naphthalene when these are applied to soil for the purpose of killing wire-worm and other pests. These substances are compounds of carbon, and they can be used by bacteria as food. Other carbon compounds, of a non toxic nature, are even better sources of bacterial nutrition; for example, cane and beet sugar (sucrose), grape sugar (glucose), milk sugar (lactose), and many others. These compounds are spoken of as carbohydrates. Amongst them is a substance called cellulose. This compound differs from many other carbohydrates in being insoluble in water. Nevertheless, although the sugar-like carbohydrates are easily soluble and can be rapidly consumed by micro-organisms, this intractable substance has not escaped the activity of the all-pervading bacteria.

What is cellulose? The name was first given in 1839 by von Payen to that material which forms the framework of all green plants. Without a framework of some kind no plant could stand up or be able to present to the air that large surface which is necessary for respiration and carbon-assimilation. Indeed, throughout the tissues of the plant each cell is enclosed in walls of cellulose. The whole framework of a young growing plant consists almost entirely of pure cellulose; as growth proceeds towards the ripening stages other and tougher substances are formed. The tissues are then spoken of as being "lignified," or made woody.

From the chemist's point of view cellulose has the formula $(C_6H_{10}O_5)n$, and is therefore related to starch $(C_6H_{10}O_5)x$. It yields glucose after treatment with hydrochloric acid. It is found in many forms in the vegetable kingdom; cotton, after cleaning, is nearly pure cellulose. The best filter-paper is one of the purest forms of cellulose that can be used in the laboratory.

To the agricultural scientist, cellulose, either pure or admixed with more fibrous material, holds a position of great importance. Cellulosic material is constantly being incorporated into the soil by the turning-in of stubbles, green manures, and of farmyard or stable manure, and to a lesser extent through dying plants and the leaves of deciduous trees. It will be easily understood that if there were no agency at work capable of decomposing the organic matter in stubble, straw, leaves, etc., at a rapid and constant rate, the earth would soon be encumbered with the remains of plants that otherwise could be destroyed only by fire.

Formation of Humus.

Whether previously attacked to any extent, or whether allowed to reach the soil in its natural form, the cellulose of plant material rapidly and completely disappears from cultivated land, leaving behind a more resistant material which is considered to be the basis of the formation of humus, and ultimately, by other influences, to be transformed into coal. The importance of this humic material has long been recognized because of its physical effects, in lightening heavy soils, in supplying organic matter to, and thus assisting the water-holding power of, light soils, and in its ability to minimise the harmful effects of acidity. The formation of this dark-coloured humus is not, however, now considered to be the direct result of the decomposition of cellulose itself; it is uncertain at present whether other related substances may not be more concerned in its production.

The first suggestion that bacteria were the causal agents in breaking down cellulose was made by

* This Journal, June, 1923.

Mitscherlich in 1850. From that time up to 1900 several workers demonstrated that micro-organisms were responsible for the breakdown. These experiments, in which filter-paper represented the cellulose, were carried out under conditions which did not admit of such adequate aeration as occurs in the

PHOTO MICROGRAPH OF *SPIROCHAETA CYTOPHAGA*.
Young culture showing sinuous rods with a few sporoid forms.

first few inches of cultivated soil. Dehérain, however, in 1884, experimented with straw, chaffed and wetted with water, and allowed it to ferment aerobically with the addition of phosphates. He obtained evidence that this type of decomposition was due to bacterial agency for, in addition to the cultures being found swarming with "vibrios," chloroform stopped the production of carbon-dioxide. By withholding the air supply he obtained two other gases, hydrogen and methane. His experiments are interesting in that they form the basis of certain developments to be mentioned later. All attempts on his part to isolate the organisms responsible for the decomposition in the straw proved unsuccessful.

Van Iterson in 1903 cultivated aerobic organisms that could decompose resistant cellulose (filter-paper), but he did not obtain a pure culture of any. He made the interesting suggestion, *inter alia*, that the destruction of wood or rope at the water-level might be due to bacteria. His cultural observations were confirmed in 1919 by Hutchinson and Clayton,† who were able to isolate and study in pure culture a remarkable organism capable of attacking no carbohydrate other than cellulose. This organism, *Spirochaeta cytophaga*, was probably that noted by van Iterson as a "micrococcus mucilage," and it is not related to any other known type of bacteria. Some of its cell-forms are shown in the accompanying figure.‡

Certain workers in America had previously announced the isolation of thirty different types of bacteria to which was credited the power of decomposing cellulose in addition to their otherwise very catholic tastes. Doubt has lately been thrown from several sources upon the claim that these bacteria were really those that acted upon the filter-paper. On the other hand, the discovery of another interesting soil organism is reported§ which is not such a dainty feeder as the *Spirochaete*, in that it can use most of the ordinary laboratory media and, in addition, can even be stimulated to attack more cellulose when other carbohydrates and related substances are added to the cellulose-media. The substances which give this stimulation, for example, dextrin, xylose, and lignin, are some that occur in natural association with cellulose in plant tissues. It was, however, the discovery of the *Spirochaete* by Hutchinson, and especially the study of its food requirements, that afforded the most important help in devising a method of making farmyard manure without the assistance of herbivorous animals, which is a new development in agricultural science.

Photo micrograph of the same organisms in its older stages; mostly sporoids, some fat.

In the process of eating, herbivorous animals take in large quantities of fibrous material, of which a great deal is indigestible but, nevertheless, has some value

† Journal of Agricultural Science, 1919. Vol. IX.

‡ By kind permission of Dr. H. B. Hutchinson.

§ Gray and Chalmers, Annals of Applied Biology, 1924. Vol. XI.

in assisting the mechanics of digestion before being voided to take part in the formation of farmyard manure. The cereal straws which form part of their food contain high percentages of "crude fibre"; ripened barley, oat, and wheat straws contain on the average 70 per cent, a large part of which is cellulose. A portion of the cellulose which passes to the alimentary tract is decomposed by micro-organisms that can work in the absence of free oxygen. The earlier experimenters concluded that hydrogen and methane resulting from the digestion of plant material could arise only from cellulose. Omelianski, in 1895, discovered two such anaerobic organisms which produced these combustible gases by decomposing filter-paper. Only lately, Mme. Khouvine, in France, has found a new anaerobic cellulose organism that is common in the human intestine, and resembles in form those isolated by Omelianski.

In addition to the crude fibrous material voided by the animal, farmyard manure as applied to the land is considerably increased in bulk by the addition thereto of straw or other litter that forms the animal's bedding. The tubular structure of straw helps to retain the liquid portion of the manure, thus increasing the value of the latter as a nitrogenous fertilizer.

It has been the almost universal experience of agriculturists and research workers that the application of unrotted straw alone to arable land has reduced the yield of the succeeding crop. The explanation of this is now understood to be as follows. When straw is added to soil the nitrogen already available in the soil is consumed by bacteria that use the carbonaceous material of straw as a source of energy; in consequence, there follows a nitrogen-minimum, a factor in plant growth of especial urgency in soils poor in nitrogen. Such a depression does not follow upon the application of well-rotted stable or farmyard manure, for a nitrogenous fertilizer, namely the urine, accompanies the straw.

Manure Shortage.

At the present time, however, stable manure is often difficult or impossible to obtain, owing chiefly to the introduction and widespread use of mechanical traction. Occasions have arisen, and may again arise, on many farms, when a large surplus of straw exists and few animals are kept. In many parts of the world there is a great deal of waste plant material, such as sugar-cane residues, which, for the reason stated above have no fertilizing value. Arthur Young commented upon the wide prevalence in his day of the practice of burning straw on arable land as a wasteful and expensive method of manuring. This practice is still followed in many parts of Canada and the United States. Moreover, soils that have been cultivated for many generations are being gradually depleted of humus. The use of mineral fertilizers cannot supply this deficiency; some substitute for farmyard manure must therefore be found.

New Methods.

The solution of the problem of converting straw into humic material without the losses attendant upon manuring with fresh straw, resulted from an investigation into the food requirements of the cellulose decomposing *Spirochaete*. Close study of this problem led Hutchinson and Richards‖ to conclude that the solution lay not in adding cultures of cellulose bacteria to the straw, but rather in making the conditions of food supply, air, temperature, etc., suitable for the activity of the cellulose bacteria already present in the straw. By analysis, bacteria in the dry state are found to contain the following percentages of carbon and nitrogen:—

C - - 50
N - - 12

It was therefore realized by Hutchinson and Richards that the activity of cellulose bacteria could be induced only in the presence of a sufficient and suitable supply of nitrogen.

For the purpose of rotting straw, the main outline of the necessary procedure was found to be as follows. A heap of straw is heavily watered; the soluble nitrogen compounds are sprinkled on and wetted so that they percolate through the heap; chalk is also mixed in to prevent acidity. By turning and mixing as necessary, the temperature is controlled and the gradually decomposing heap is thoroughly aerated. The controllable factors for success are, therefore, air, temperature, and soluble nitrogen compounds. Given these conditions, straw can be rotted down by micro-organisms in such a way that its essential tubular structure and fibrous nature are retained and the resulting product closely resembles farmyard manure both in texture and in fertilizing power.

The above experimental work has resulted in the development of a process for making synthetic farmyard manure on a large scale. Field trials showed that the artificial product was equal to or even better than cake-fed bullock dung. The cost of labour in the case of the synthetic manure was much lower than in that of manure produced under stock. The process is now being used in many parts of the world where the two absolute necessities, water and suitable

‖ Journal of the Ministry of Agriculture, 1921-22. Vol. XXVIII.

nitrogen compounds, are readily obtainable. A great variety of plant remains are amenable to this treatment, such as, for example, bracken, banana leaves, Brazil grass and other grasses, Nile sudd, rice straw, maize stalks, sugar-cane waste, garden refuse, and other similar substances of a cellulosic nature.

In cases where the necessities, water and nitrogen, are not procurable, there arises the problem of how to utilize unrotted plant remains. The difficulty of preventing losses that follow in the succeeding crop after plowing-in fresh straw might yet be overcome. We have seen that the straw contains energy materials which bacteria use and, in so doing, deplete the soil of its store of available nitrogen, thus competing with and starving out the crop. Certain plants, however, the legumes, are independent of these nitrogen compounds in the soil, for they have in their roots bacteria that can obtain nitrogen from the air. This nitrogen they hand on to the host-plant for its own use. It is thus possible that the plowing-in of fresh straw might be carried out with beneficial results if followed by a leguminous crop.

A beginning has been made at Rothamsted to investigate the action of straw upon the development of root nodules on legumes. Thornton¶ has found, for example, that the addition of fresh chaff to soil in pot cultures resulted in an increase of nodules on the roots from 234 to 636. The roots, however, were not correspondingly increased, so that the plants did not benefit as much as they should have from the greater number of nodules. The addition of phosphate to the soil with the straw was then tried, for phosphate is known to increase root development. This treatment gave, in addition to more nodules, a considerable increase in crop. It is hoped to develop from this experimental work a system of manuring with unrotted straw followed by a leguminous crop, so that the losses usually attendant upon the incorporation of cellulosic material into the soil may be overcome.

¶ Journal Society of Chemical Industry, 1923. Vol. 42. (Discussion)

ROYAL SOCIETY OF ARTS, 171st SESSION, 1924-25.

ARRANGEMENTS for Meetings from January to March, 1925 :—Monday, 2nd February, 8 p.m. (Cantor Lectures). V. E. Pullen, Director Radiological Research Department, Woolwich. "Radiological Research—A History." (Lecture III).

Wednesday, 4th February, 8 p.m. (Trueman Wood Lecture). Sir Ernest Rutherford, M.A., D.Sc., F.R.S. "The Stability of Atoms."

Friday, 6th February, 4.30 p.m. (Indian Section). J. T. Marten, M.A., I.C.S. "The Indian Census." Sir Edward Albert Gait, K.C.S.I., C.I.E., will preside.

Wednesday, 11th February, 4.30 p.m. (Ordinary Meeting). Sir J. Fortescue Flannery, Bt., Past-President of the Institute of Marine Engineers. "The Diesel Engine in Navigation." Lord Bearsted, LL.D., will preside.

Monday, 16th February, 8 p.m. (Cantor Lectures). Walter Rosenhain, B.A., B.C.E., D.Sc., F.R.S., Superintendent of the Department of Metallurgy and Metallurgical Chemistry at the National Physical Laboratory. "The Inner Structure of Alloys." (Lecture I).

Wednesday, 18th February, 8 p.m. (Ordinary Meeting). J. S. Owens, M.D., Assoc.M.Inst.C.E., F.G.S., Superintendent Advisory Committee on Atmospheric Pollution, Air Ministry, Meteorological Office. "Modern Atmospheric Conditions."

Monday, 23rd February, 8 p.m. (Cantor Lectures). Walter Rosenhain, B.A., B.C.E., D.Sc., F.R.S., Superintendent of the Department of Metallurgy and Metallurgical Chemistry at the National Physical Laboratory. "The Inner Structure of Alloys." (Lecture II).

Tuesday, 24th February, 4.30 p.m. (Dominions and Colonies Section). R. H. Brackenbury, Member of the Empire Cotton Growing Corporation Mechanical Transport Sub-Committee. "Transport in Tropical Africa."

Wednesday, 25th February, 8 p.m. (Ordinary Meeting). Sir Dugald Clerk, K.B.E., D.Sc., F.R.S. "The Power of Internal Combustion Engines for Motor-cars." Hon. Sir Charles A. Parsons, K.C.B., LL.D., D.Sc., F.R.S., will preside.

Monday, 2nd March, 8 p.m. (Cantor Lectures). Walter Rosenhain, B.A., B.C.E., D.Sc., F.R.S. Superintendent of the Department of Metallurgy and Metallurgical Chemistry at the National Physical Laboratory. "The Inner Structure of Alloys." (Lecture III).

Wednesday, 4th March, 8 p.m. (Ordinary Meeting). Professor W. E. S. Turner, O.B.E., D.Sc., F.Inst.P., Department of Glass Technology, University of Sheffield. "The Modern Production of Sheet-Glass."

Friday, 6th March, 4.30 p.m. (Indian Section). Sir Henry Sharp, C.S.I., M.A., C.I.E. "The Development of Indian Universities."

Wednesday, 11th March, 8 p.m. (Ordinary Meeting) Emile Cammaerts. "The Restoration of Public Buildings in Belgium."

Wednesday, 18th March, 8 p.m. (Ordinary Meeting) Claude N. Friese-Greene. "Colour Cinematography."

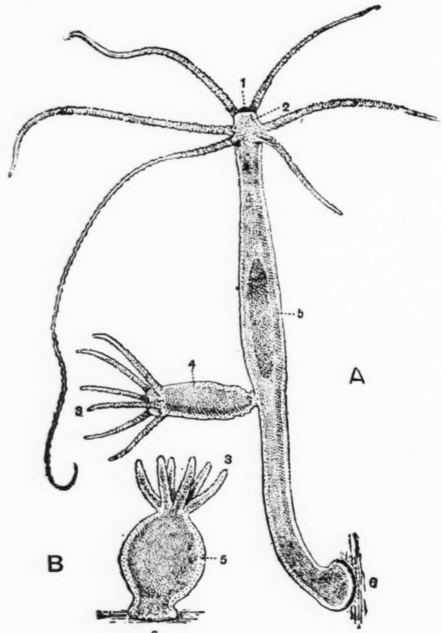
Wednesday, 25th March, 8 p.m. (Ordinary Meeting). Henry G. Dowling. "Wall-papers."

The Hydra or Freshwater Polyp

By Sir Arthur E. Shipley, G.B.E., F.R.S.

Although Hydra is not a very large genus, specimens of the commoner forms can usually be found by the pond hunter adhering to the thread-like roots of duckweed. They are one of the most entertaining objects for study under the lower powers of a microscope.

A VERY common larval form which occurs in all the great groups of animals is known as the *Gastrula*, and the gastrula is formed of two layers of cells. It is, as it were, an india-rubber ball, one half of which has been pushed in until it touches the inside of the other half. This leaves a ball-shaped cavity with a wide mouth, but in the gastrula this mouth soon contracts and is only for a short time equivalent in size to the cross-section of the larva. The *Hydra* is, in effect, a permanent gastrula attached to some submerged object at one end, that opposite the mouth, but the mouth is usually surrounded with a number of thread-like outgrowths, the tentacles.



A. Expanded condition. This specimen is budding off a young Hydra. It contains a large food mass in its coelenteron, probably a Daphnia or some other fresh-water crustacean.

B. Retracted condition. 1. Mouth. 2. Oral cone. 3. Tentacles. 4. Bud. 5. Endoderm. 6. Foot.

From Shipley & McBride's "Zoology."

Hydra seems to be a cosmopolitan genus and not a very large one. Schulze has divided it into three genera and some ten species, but recent workers doubt his classification, for any individual *Hydra* shows as time passes a considerable amount of change in its colour, size and habits. The two commonest forms in the streams and pools of our country are *Hydra fusca*, of a yellow or light brown colour, and *Hydra viridis*, which has a bright green hue due to numerous chlorophyll-containing corpuscles which lie within the cells that form its body. The base of the tentacles are not quite close to the lips of the mouth, but arise a short way behind, thus leaving a small cone-like protuberance known as the hypostome. In number they vary from six to ten.

As a rule the little creature is firmly attached to its subtratum, but it can release itself at will, and then it creeps along aided by its tentacles or performs a looping motion like a leech. Both species are a very fair size, from the foot to the tip of the tentacles may be as much as 15 mm., but all parts of the body are very contractile and when irritated the whole collapses into a more or less spherical lump. It is essentially a carnivorous creature and feeds upon certain water-fleas such as *Daphnia*, and more rarely *Cyclops*, *Cypris* and occasionally it eats small insect larvae. Larger specimens of water-fleas are frequently caught, but generally make their escape. All these water-fleas have a hard, indigestible, horny cuticle, and when the softer parts have been absorbed by the *Hydra* this cuticle is ejected through the mouth. The prey is caught by means of certain piercing structures called nematocysts, which are especially common on the tentacles. They occur in the outer skin of the body, the so-called ectoderm, and are formed in special cells which have a little projecting process or spike. When the spike is touched the nematocyst explodes, the projecting spike acting as a trigger. A thread which has been coiled up in its body is shot out and this pierces the skin of an enemy or of an animal destined to form food.

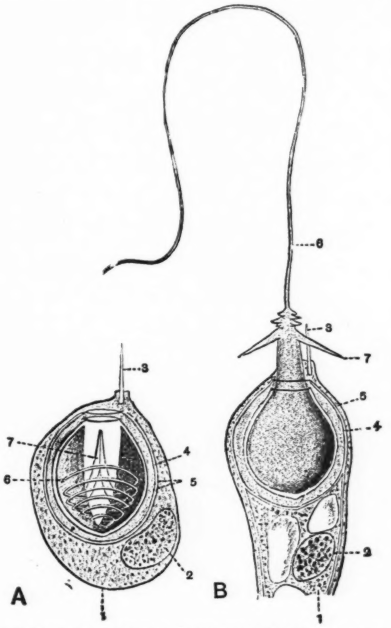
The digestive fluid inside the cavity of the *Hydra* is alkaline, but it seems to have no effect on other specimens of the same genus, for Miss Marshall records having "seen one Hydra completely ingested by another in whose inside he remained for more than twelve hours, and was finally ejected again none the worse."

The cells of the ectoderm split up at their base into two or more processes like an inverted T, and these processes are applied to a somewhat con-

tractile membrane which separates the outer layer of cells from the inner layer of cells. These processes are contractile—in fact they are elementary muscle fibres, and it is by their contraction that the animal shrinks in length. These contractile fibrils may be as long as 0.35 mm., and are arranged longitudinally. Each cell has a large nucleus and a very vacuolated protoplasm. Between the bases of the ectoderm cells, which are shaped rather like wine-glasses, in the ample space between their stems are a large number of interstitial cells, and it is these cells which produce the nematocysts.

Reactions.

Hydra reacts rather slowly to stimuli. If gently teased with a finely drawn out glass rod a tentacle will contract. If a stronger stimulus be applied the tentacle will contract over the mouth and then the other tentacles bend upwards till they meet and the " head " turns aside. Tickling the hypostome or the base or foot with a glass rod leads to the contraction of the body. When pieces of a *Daphnia* are made to touch a tentacle the " capture response " is set up and the piece of food is brought towards the hypostome, the other tentacles bending over it to prevent its escape. Application of very weak acetic acid causes a contraction of the tentacles and the so-called " capture response " is set up. The body is also apt to swerve away from the irritant. The foot and the hypostome seem to be the parts of the animal most susceptible to mechanical stimuli.



CNIDOBLAST WITH LARGE NEMATOCYST FROM THE BODY-WALL OF HYDRA FUSCA. HIGHLY MAGNIFIED. FROM SCHNEIDER.

A. Unexploded. B. Exploded.
1. Cnidoblast. 2. Nucleus of cnidoblast. 3. Cnidocil. 4. Muscular sheath. 5. Wall of nematocyst. 6. Thread. 7. Reflexed processes.

From Shipley & McBride's " Zoology."

The nervous system consists of a series of modified branching cells derived from the intersticial cells at the base of the ectoderm cells. They are of two forms: one, somewhat columnar epithelium-shaped cells whose bases end in only one nervous process; the others, scattered through the base of the ectoderm, are ganglion cells with many processes which are prolonged from each angle of the cells. There may be two or more of these processes, and some of the branches end up by fusing with similar processes from neighbouring nerve cells. Thus some of the branches from neighbouring cells fuse together whilst others are attached to the muscular ends of the ordinary ectodermal cells. These nerve cells are especially concentrated at the foot and round the mouth, and are less common in the centre of the body. The whole system is, of course, diffuse. There is no brain or nerve cord, only a network of nerve cells extending through and between the ectoderm and endoderm cells. Very weak chloroform causes a curious rhythmic contraction of the *Hydra* and finally the animal becomes anaesthetized. Chloroton, which in human beings is used to prevent sea-sickness, promotes a contrary effect in a *Hydra*. When it is used the *Hydra* shows discomfort and yields up through its mouth masses of endoderm cells.

The nematocysts are divided into three kinds, the first of which are pear-shaped. Their names indicate their functions.

Weapons.

(1). *Penetrants.* These are large pear-shaped nematocysts which are used for piercing the horny shell of the water-fleas. The three large barbs which become conspicuous when a nematocyst has exploded are used as a stiletto which pierces the cuticle of the prey and thus makes the hole through which the filament enters. The barbs are then withdrawn backwards and stick out in a tri-radiate fashion. Apparently some chemical action accompanies the piercing. This is shown by sections made through the cuticle of a captured water-flea. Probably the secretion is poisonous. The thread which is thrust into the body has on it rows of minute pores through which fluid can also escape as it can through an opening at the end of the thread. These *penetrants* are the lethal weapon of the *Hydra*.

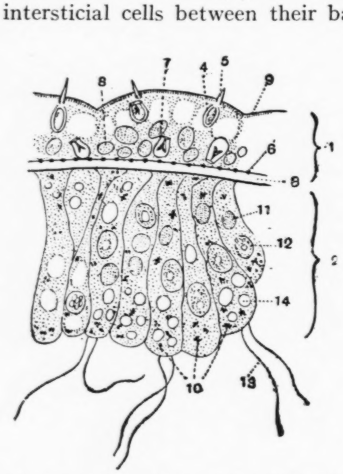
(2). *Volvents.* Volvents are small pear-shaped nematocysts. When they explode their thread winds tightly amongst the hairs or bristles of the crustacean prey and holds it captive until it has been stung to death by the penetrants. The thread cells of the volvents coil tightly and in an optical section minute hairs can be seen set on the axis. It is also thought that they secrete some sticky secretion.

(3). The third form, the *Glutinants*, are of two sizes. They are not pear-shaped but cylindrical, and one sort is bigger than the other. When the *Hydra* sticks on to its substratum it is by means of the sticky filaments that these glutinants secrete. The secretion seems to harden in water and the attachment is very firm, so firm, indeed, that a *Hydra* in its efforts to pull away the tentacle which is adhering to a glutinant often breaks the tentacle.

Cell Structure.

The size of the nematocyst is frequently used as a means of determining the species, but they vary so much in individual animals that their value for this purpose is almost negligible.

The endoderm cells are closely packed together with very few intersticial cells between their bases. Like



SECTION THROUGH THE BODY-WALL OF HYDRA FUSCA. HIGHLY MAGNIFIED. AFTER SCHNEIDER.

1. Ectoderm. 2. Endoderm. 3. Mesogloea or structureless lamella. 4. Nematocyst. 5. Cnidocil. 6. Muscle-fibres of ectoderm cells cut across. 7. Nucleus of ectoderm cell. 8. Interstitial cells. 9. Cuticle. 10. Pigment granule. 11. Food granule. 12. Nucleus of endoderm cell. 13. Flagellum. 14. Water vacuole.

From Shipley & McBride's "Zoology."

the ectoderm cells they are prolonged into muscular fibrils which, however, run around the body and not up and down it. By their contraction the outline of the body is narrowed and elongated. Some of these cells may produce flagella from time to time, or amoeboid processes which project into the cavity of the body. Others are definitely gland-cells and pour out a secretion which aids in digestion. But it is also believed that the individual cells absorb solid particles just as an amoeba does, for inside them are often found food particles and indigestible nematocysts which are ultimately ejected with other indigestible matter.

But the interstitial cells, those little cells tucked away amongst the bases of the ectodermal cells, besides providing the nematocysts have another very important function. They form the ova and the spermatozoa. The breeding season of the two commonest species in our country varies. *Hydra veridis* produces its eggs and spermatozoa during the summer, whilst *Hydra fusca* delays their formation until October or November. As a rule both ova and spermatozoa are produced by the same animal, a condition of things which is described by the adjective hermaphrodite or monoesious. At the time of the formation of the eggs the interstitial cells multiply abundantly and form a mass which bulges out into the ectoderm. This little swelling can always be distinguished from an initial bud by the fact that the latter contains a layer of the endoderm cells whilst the former does not. In this mass of cells one of them begins to get a little bigger than the others, and finally it eats the others or many of them up and thus greatly increases in size, just as happened in Joseph's dream about the kine. As it develops it forms a hemispherical mass of protoplasm with lobed edges and this lies in contact with the basement membrane. As a rule there is only one ovary at a time with but one ovum, and it is usually found about one-third of the body length from the foot, whilst the testes are generally borne on the upper third of the body. The egg-cell, which is now a very large one, stretches the ectoderm until it is covered by but a thin membrane. After a time this membrane ruptures, and the egg, now naked except for a thin gelatinous coating, is ready for fertilization. Before fertilization the ovum is an amoeboid cell which it is impossible to distinguish from a free living amoeba except by watching its development.

Reproduction Methods.

The testes arise in very much the same way. There is a great growth of the interstitial cells. After several processes of division the spermatozoa are formed. Each has a conical head containing the nuclear matter and a fairly long vibrative tail, by the lashing of which it moves and makes it way through the water to the ovum. The division of the egg takes place whilst the egg is still associated with the body of its parent. The young *Hydra* finally creeps out of its shell and attaches itself to some extraneous object.

But *Hydra* also multiplies asexually. It can throw out a bud. At first a small knob involving both layers appears and this increases in length till it may almost equal its parent, then it forms a mouth at the free end and throws out a ring of tentacles around it. The bud may even have a secondary bud on it, and thus we get a small colony such as is so common in the higher groups of Coelenterata.

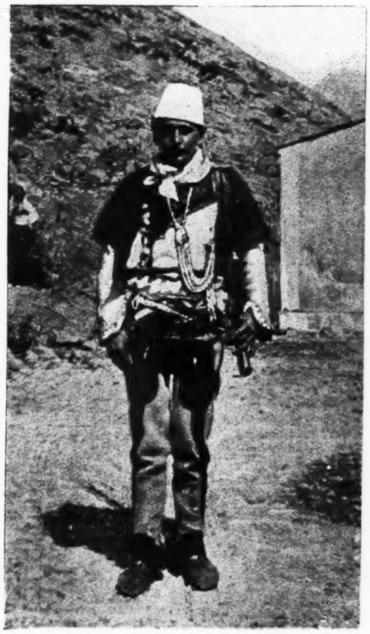
Tribes of Northern Albania

By M. E. Durham.

Author of "High Albania," "Twenty Years of Balkan Tangle," etc.

We hear little of Albania nowadays. Probably because publicity is the last thing desired by those interests whose objective is concessions and the right of exploitation of the people. Albania is still, however, an independent state and not a Serbian dependency.

OF the new states which have arisen in Europe out of the wreckage of old empires the one which has been least understood and the most unlucky—for during the war, although her independence and neutrality had been guaranteed by all the powers, Albania was entered and more or less overrun by no less than seven armies—is Albania. But the history of the Albanian people is a very remarkable one, for few peoples have shown greater tenacity to their language and customs than have the Albanians. The Albanian represents those ancient inhabitants who filled the Balkans before the Roman invasion and conquest of the peninsula. Even the Roman was a long while subduing the Illyrian as he was then called. And the conquered native finally became a great force in the Roman army, and ultimately rose to the purple. Diocletian, Constantine the Great, Justinian and other emperors of lesser note had Balkan blood in them.



BOY OF THE BOGA TRIBE.

Christianity reached Illyria at a very early date. "Round about unto Illyricum have I fully preached the gospel of Christ," says St. Paul. The bishoprics of Albania are of ancient date.

Accursed Slavonians.

Into this Christianized and partly Romanized land poured the Slavs, the latest comers of the Balkan peoples.

John of Ephesus gives a contemporary account of their first appearance. "The third year after Justinian was famous for the invasion of the accursed people called Slavonians . . . And four years have elapsed and because the king is engaged in war with the Persians . . . they spread far and wide and ravage and burn and take captives. They have ridden to the outer wall of the town (Byzantium) and driven away thousands of the king's horses and even to this day (A.D. 584) they still dwell free from fear and slay and burn . . . and have learned to fight better than the Romans, though at first they were rude savages and dared not show themselves outside the forests, and as for arms did not know them except for two or three kinds of javelins or darts."

Serbian Collapse.

The Slav problem of the Near East then began. The struggle between the old inhabitant and the invader has never ceased.

A number of old documents relating to Serb rule in the Middle Ages show the Albanian in districts far wider than modern Albania, as serf or herdsman under the ruling Serb feudal nobleman. Serb kings hand over Albanian villages and mills as gifts to Serb monasteries and so forth.

And when the Serb kingdom fell to pieces in the 14th century the Albanians were among the first to break loose. Since then the Albanian has weathered also the Turkish storm. This remnant of an ancient people has retained its language and its strong individuality against all comers.

Strabo writing in the first century A.D. describes the Illyrians and Macedonians as divided into tribes and says "the persons who hold office are called *peligones*." Among the Albanian northern mountains the tribes still maintained semi-independence under Turkish rule, and each tribe managed its internal affairs by means of a council of elders. An old man in Albanian is "plak" or "pelak," which is evidently the same word as Strabo's "pelig"—the termination "ones" being probably a Roman addition.

The Turkish conquest in many ways was as great a misfortune to the Albanian as to the other Balkan people. It broke the independent state made by the great Skenderbeg. But it later enabled the Albanian to retake much of the land which the Slav had taken from his ancestors. The Serb fled into Austria where he was protected and given land, and the Albanian reoccupied the lands he had left. The Albanian language spread as far as Monastir in Macedonia.

Had Lord Fitzmaurice and Lord Goschen when in 1880 the Eastern Roumelian commission was regulating the results of the Russo-Turkish war of 1877, succeeded in their plan of forming a large autonomous Albania, by this time the Albanians would have been a strong power in the Balkans. But Great Powers who coveted Albanian lands did not permit this to be done. And when in 1913 Albania, after centuries of struggle, finally won recognition she was shorn of some million inhabitants and some of her most fertile land and most important towns.

And during the war, though she was much devastated no one has paid her reparations. Since the war, moreover, she has been more than once attacked and invaded by the Serbs. But so far the League of Nations has stood her friend and ordered back the invaders.

Hard as has been her lot, the sturdy individualism of the Albanians gives hope that given time, they will yet play a part in the development of the Near East. In intelligence, as those who have travelled among them have found, they are second to none of the other Balkan peoples.

The Changing Age.

The perpetual struggle to hold their own against all comers has naturally led the Albanian to guard jealously his old customs. In no other part of Europe, perhaps, has the Great War made such sweeping changes as in the Balkans, where the peoples have been jumped in many cases from the middle ages to the twentieth century without time to take breath.

Under the Turk, no schools, except such as were under foreign protection, were allowed to teach in Albanian. As this is the only tongue spoken by the bulk of the population education was severely handicapped, though the schools opened by Austria and Italy were taken full advantage of.

But now the schoolmaster is abroad. The first thing done by the Albanians on obtaining independence was to open as many schools as their rather straitened means allowed.

The ancient beliefs and customs that lingered in the remote mountain fastnesses and are of extreme interest to all students of the past, will disappear more and more rapidly.

We will therefore touch on some of these rather than on the present political and other questions, with the hope that some student of anthropology will be tempted to make further studies on the spot before the passing away of the older generation, carries much old lore into oblivion.

Folklore and Customs.

When I visited the northern tribes in Turkish times, the council of elders still ruled them. These elders were all House-lords (zoti i shpis) that is, heads of families. The families included a number of cousins and among the more isolated tribes such a family might amount to some sixty or more persons. But smaller ones were usual. The headship was inherited from father to son by the eldest son, unless he were considered a quite incompetent person. The head was obeyed. I have seen a young man of not more than eight and twenty ordering his much older uncles. "But why do they obey him?" I asked. "Because he is the head appointed by God" I was told.

In such a place one learns the meaning of the divine right of kings.

The council of elders decided all matters within the tribe—wood-felling rights, irrigation rights, pasturage, etc. In case of quarrels with another tribe, it met delegates from that tribe and argued the point. The law was called the Canon of Lek Dukaghin after a celebrated chieftain of the 14th century, but was doubtless handed down from a far earlier time and rearranged or modified by Lek. It had also been modified by the elders of different districts in more recent days, and so was not the same in all tribes, in certain details.

And it had never been written down till collected and written recently by Bishop Miédia and Dom Kol Asti.

Theft within the tribe was punished by making the thief restore double what he had stolen and such theft was not common.

Theft from land that was church (in the case of the Catholic tribes) or mosque property (for the Moslems) was punished by the restoration of four or five times the value. Part of the fine went to pay the expenses of the elders who often had to come long distances. If a house or cattle-yard were broken into an extra fine of 500 piastres was payable. An accused man had to find con-jurors who would swear to his innocence. Not necessarily witnesses in our sense of the word. The number of con-jurors varied according to the

nature of the crime. A man accused of murder within the tribe had to find twenty-four. For theft of anything but livestock twelve. For horse-stealing, eight ; for cattle stealing, six ; for sheep or goats, two. And so forth.

For a murder within the tribe the murderer was expelled from the tribe, his ground confiscated, his house burnt and often his fruit trees felled.

Some tribes gave the land to the relatives of the murdered man. A fine of some 3,000 piastres was also exacted.

In some tribes blood vengeance within the tribe was not permitted. In others the relatives might take blood if they did so at once on the first day.

In the case of the murder of a member of another tribe, that tribe might take vengeance.

Blood Tax.

As the Turkish government always took part of the fines paid for murder, it rather encouraged the taking of vengeance as a source of revenue. Now efforts are being made with success to put an end to an ancient and bad custom, and it will soon become a thing of the past as in other lands.

In the case of wounds, fines were exacted in proportion to the wound. In making peace after a feud, it was customary for the Elders to reckon up the injuries on both sides. Thus a death on one side was balanced by one on the other. And so were wounds. For the balance, fines had to be paid no matter which party started the quarrel. A system which is far more just than the system of "reparations" in force in the rest of Europe, where the victor may extort what he can.

These tribes were and are strictly exogamous. That is that no marriage could take place within the tribe which reckons descent from one male ancestor. In tribes which include two unrelated stocks intermarriage of those stocks can take place.

A very ancient custom which was not yet extinct when I visited the tribes was that in the more remote of the Dukaghin tribes, the Levirate was still practised in spite of the efforts of the priests to suppress it. On the decease of a tribesman it was held the duty of his brother or failing a brother, his nearest male relative, to marry the widow, even if he had already a wife. I came across several cases. But the custom is probably now extinct. I remember that of a young man who was deeply distressed because the priest had excommunicated him and all his household on account of such a marriage. In this case he had no other wife. He repeatedly said that he could not promise to put her away as bidden, for it was a duty he owed to his brother. The woman was childless, and it appeared that a child born to her later would rank as that of the dead man. As it did in Old Testament days.

MEN OF SHALA.

The ancient cult of the hearth also was not extinct among these people. Among the Pulati people when a new house was built the first fire had to be ceremonially lit by the house lord who had to enter the house nude. When the fire was lighted the rest of the household could enter.

I was told that the fire was ceremonially extinguished by the women if the last male of the house died. As a rule the hearth fire being of wood and banked up always at night, was not extinguished for years.

Voyage of the Soul.

At death the soul was believed to come from the the mouth and walk three times round the corpse before departing. It then had to travel back to the place at which it was born, visiting on the way every place in turn in which the man had ever been during his life. After this, which might take years, the soul conformed either to Christian or Moslem custom, according to its beliefs during life in this world.

Both Christian and Moslem tribesmen seemed to think heaven was on the summit of an immensely high mountain.

The name tabu—the desire to conceal a person's name lest evil spells be worked with it—a tabu to be found in very many lands, was not extinct. Women refused to mention the name of their husband. I was told it was not modest to do so. Their trouble when asked for the name was very marked. They would even burst into tears. And when, while doing relief work after war, it was necessary to make accurate lists of refugees, such names had to be obtained from other women.

Among the men in some districts it was customary not to use the baptismal name, but to adopt another for use on growing up. A custom combatted by the priests but stuck to with some pertinacity.

As in other primitive places, there was, of course, a widespread belief both in the evil eye and in witches, and magicians. Of the latter I was told a tale which the tellers believed firmly. A certain magician did so much harm by his spells that the local Pasha imprisoned him. He languished some time in prison till one festival day the Pasha was entertaining guests. The party was a very dull one, and by way of enlivening it, some one suggested that the imprisoned magician should be released to entertain the company. No sooner said than done. The magician was willing to oblige, and all the apparatus he needed was a large bowl of water. This was fetched and he asked the company what foreign town they would like to see in it. Someone suggested Malta. The magician after performing a little magic asked the company to look in the bowl. There, sure enough, was the port of Malta, all the houses, people and ships clearly visible. Alongside the quay was a large steamer getting up steam and preparing to cast off. "Noble Pasha," said the magician, "have I your permission to go away in the ship?"

"Certainly," said the Pasha much amused. The magician solemnly lifted his foot and put it on board the steamer in the water bowl. And he disappeared and was never seen more. That he steamed away from Malta in the ship is clear to the meanest intelligence.

The future is told from the blade bones of sheep and the breast bones of fowls. Remnants of the ancient Greek and Roman prophecies by means of animals possibly. The bone is held against the light and the markings made by the marrow and the situation of little holes or white patches are interpreted by those who know the lore.

The last time I heard a bone read it came fatally true. It was in June, 1914, on the shore at Durazzo. Among a crowd of officials and foreigners down by the quay there came in search of me a ragged lean man from the distant mountains. He drew a fowl's breast-bone from his shirt and held it against the sun-glare very anxiously and asked my opinion.

He said "I see blood. Nothing but blood. Blood everywhere. What can it mean?" Some educated Albanians laughed at him. But he persisted. I remember his eager dark eyes and his anxious face and the little bone which shone crimson in the sun. And alas he was right. But a few weeks saw the Great War. And blood was everywhere.

To those who have the enterprise to go to Albania to collect the ancient lore that still remains, I would say that though a certain amount of roughing it must be put up with, the welcome that the traveller meets with makes up for it. The scenery of the mountains is second to none in Europe and the climber may climb unknown peaks.

Every sympathetic traveller who visits Albania is a help to a brave people which is faced with difficulties.

And those who would search for the remains of the old world lore of Europe should go before the exploiter and concessionaire who are hovering over the land, have got their claws into it.

Books Received.

Mass Spectra and Isotopes. DR. F. W. ASTON. (Oxford University Press. 1s. net).
Bibliographie de la Relativite. Par MAURICE LECAT.
The Relations of Geography and History. By the late H. B. GEORGE, M.A. (Oxford, at the Clarendon Press. 5s. net).
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A number of others received will be acknowledged in the next issue, but are temporarily held up owing to pressure on available space.

The Monazite Sand Industry and its possible By-Products

By Edward Cahen.

Author of "The Mineralogy of the Rarer Metals."

The Monazite Sand industry furnishes an excellent example of the way rare minerals unknown except as laboratory curiosities slowly develop into commercial products of ever-widening application

Of the countless thousands that have passed the turnstiles of the British Empire Exhibition, some have gone aimlessly to see the great exhibition, some to enjoy the thrills of the Amusements Park, and some to study those exhibits in which they are particularly interested. Among the latter, the writer was so struck with the ubiquity of the monazite sand to be found in practically all the colonial exhibits, that he thought readers of Discovery might like to know something about this sand with an interesting past and a hopeful future.

Its name *monazite*, derived from a Greek word meaning "to be solitary," given to it on account of its supposed rarity, has proved to be ill-chosen; for it would not be an exaggeration to say that wherever it has been looked for there it has been found. In our Empire alone it occurs in Australia, India, Ceylon, Federated Malay States, South Africa, Nigeria, and even in the Gold Coast.

Where Monazite is Obtained.

When Auer von Welsbach discovered, after much patient research, that thorium, one of the scarcest of the rarer metals, produced a brighter light than any other known material if rendered incandescent, the only sources of supply were several very rare minerals sparsely distributed in the Scandinavian peninsula. It was obvious, if any commercial success were to be made of his discovery that a more prolific source of the raw material must be discovered from which to obtain the thorium. The German find of monazite on the shores of Brazil not only ensured the success of Welsbach's discovery, but actually laid the foundation stone of a new industry—an industry which the Germans managed to keep in their own hands for many years, right up to 1914 in fact. Up to this date Hamburg was the central market for the sale and distribution of monazite, but to-day the market is in London, a market moreover free from monopoly, where any bona-fide purchaser may obtain at a fair price all the monazite he requires. Further, the controlling source of supply has shifted from the shores of Brazil to the shores of our own Empire across the seas in Southern India.

Though monazite sand is found in so many localities, it is only in certain of them that it is present in sufficient quantity to allow of its being worked economically. Hitherto but four localities have been worked on a commercial scale: Brazil, North and South Carolina in the United States, Travancore in South India, and quite recently Ceylon. There appears to be no reason why the sand should not be recovered and exported from the Federated Malay States, where it occurs with the alluvial tin, if only there were sufficient demand for it. The Travancore sand is, however, of such excellent quality and present in such quantity as to be able to meet all present demands, and, probably, any that may arise in the future, for the consumption of thorium in the manufacture of gas mantles appears to be a more or less fixed quantity, which shows signs of diminishing rather than of increasing.

Monazite sand is essentially a phosphate of cerium containing small amounts of thorium. It is bought and sold on the thorium content for it is to this small amount of thorium that its value is due. It has been found essential to the economic working of the extraction process that the thorium content of the raw material should not fall below five per cent. The monazite originally found on the shores of Brazil had very conveniently been concentrated by Nature, the tides having washed away the lighter impurities and left behind practically pure monazite. All the Germans had to do was to ship the sand as ballast and say nothing about it. It was some time, indeed, before the Brazilian Government discovered what was happening and levied a tax on the export of the sand, which the German firms gladly paid. To-day it is found necessary to supplement the sorting action of wind and wave. Three methods have been used, two of which endeavour to imitate Nature. Of the latter, however, the method which has been found to be more satisfactory is the one in which advantage is taken of the difference in gravity of the various constituents. The sand is fed on to specially-designed tables of which Fig. 1 shows a type. The tables are grooved and slightly tilted at one corner. Along one side water trickles through a number of little jets, well seen in the illustration, while the table is kept constantly jerking. In this way the sand separates into its constituents which fall off the table at different points at the far end and are there collected.

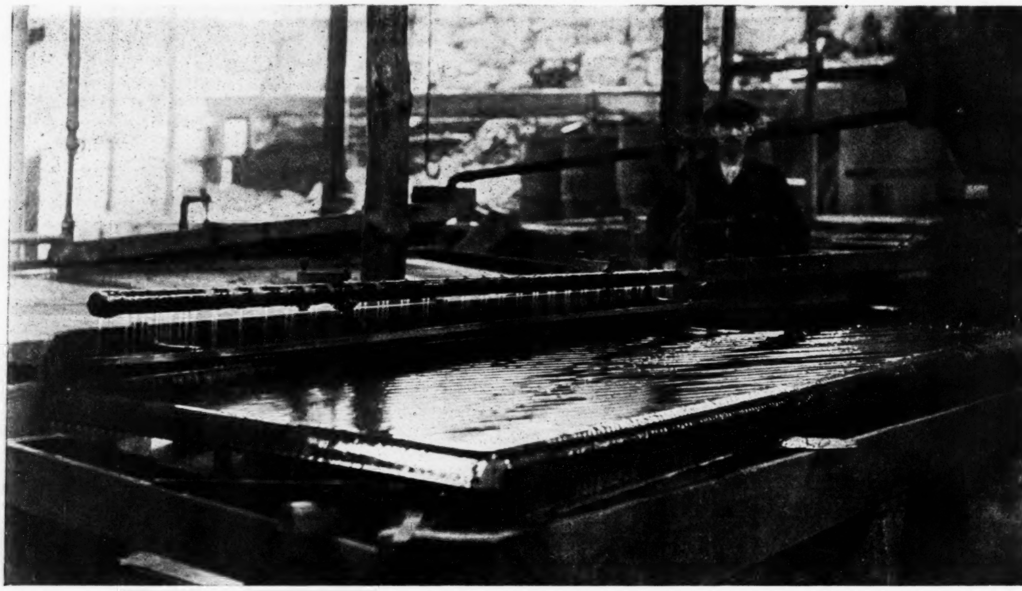


Fig. 1.—TABLE ON WHICH THE MONAZITE IS CONCENTRATED.
It imitates the action of the tides, and sorts the sands by the different gravities of their constituents.

Crude monazite usually consists of ilmenite, garnet, zircon, and quartz granules as well as the monazite proper. Though the method of washing on a table, such as has just been described, is very effective, this is usually followed by a further process.

Magnetic Separation.

This is known as magnetic separation and the principle here involved is the same whatever form of machine is used. The photograph (Fig. 2) shows a "Rapid" Magnetic Separator. The sand is fed on to a moving band which conveys it to electro-magnets of varying strength. As the different constituents arrive under the magnet of the requisite strength, they are lifted and then deposited into the various shutes shown in the photograph from which they are received in receptacles placed to catch them. The monazite being the most feebly magnetic is the last product to be removed and the magnetic field is of the highest intensity at this stage.

It is astounding how effective this separation is. The writer has examined microscopically specimens of ilmenite, garnet and zircon obtained from crude Travancore sand and can vouch for the purity of each of them. It is very curious to compare the crude sand with the practically pure monazite from which the black ilmenite, the red garnet and the pink zircon has been removed. The pure monazite has a beautiful golden-brown colour.

The sand is sampled and assayed in India and exported in small one-cwt. bags. These are made double to prevent leakage of the sand which is very fine. The Indian sand has long been sold under a guarantee of nine per cent thorium, but it often passes this figure. At present the price, fixed on the thorium content, is about £3 per unit f.o.b. in India. Very little can be said about the actual extraction of the thorium from the sand as the process, a long and tedious one, is a trade secret which is jealously guarded.

Prior to 1914 practically the only countries producing thorium nitrate were Germany, France, Austria and America. To-day it is being made in England and the United States, and the requirements of the gas mantle factories in Great Britain are met entirely with British thorium nitrate made from Travancore sand.

Utilization of the By-Products.

The annual world consumption of mantles some ten years ago was estimated at roughly three hundred million. Allowing half a gram of thorium oxide for each mantle and an average yield of five per cent from the sand, the world's consumption of monazite worked out at 3,000 tons each year, a figure which agreed pretty well with the average annual production of the sand as shown by statistics.

When it is realised that every hundred tons of monazite not only produces five tons of useful thorium

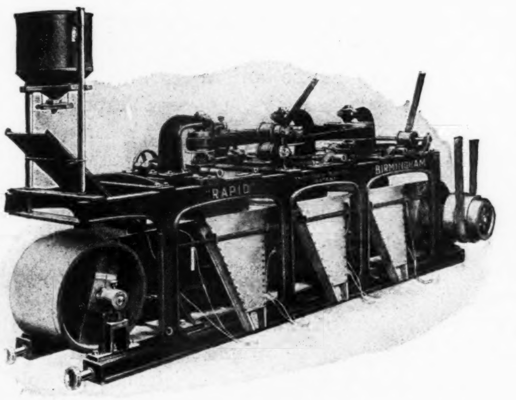


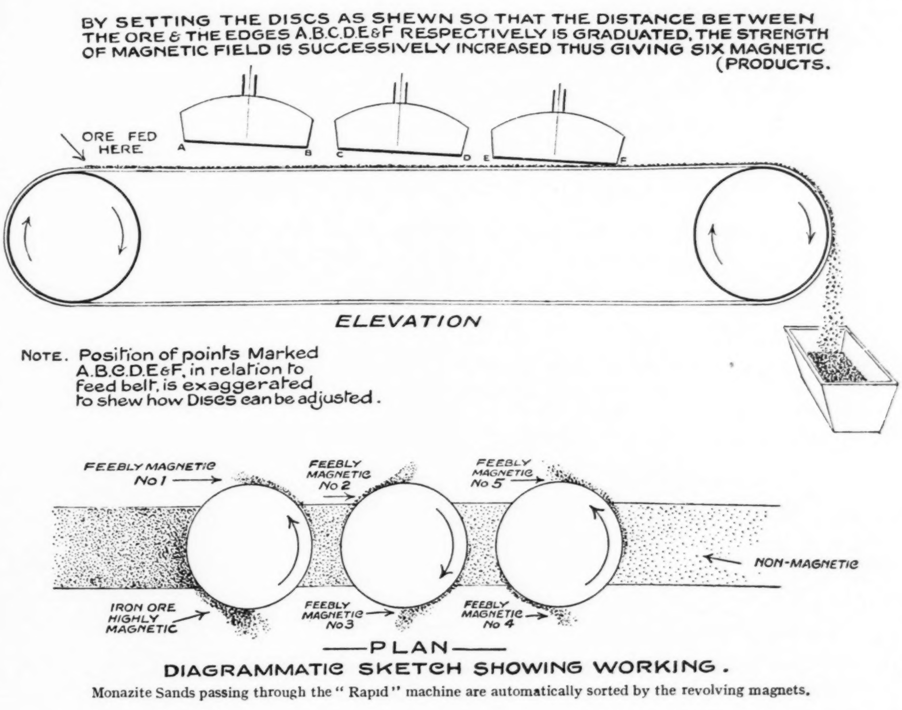
Fig. 2.—THE "RAPID" MAGNETTING MACHINE FOR ORE SEPARATION.

but also some 60 tons of cerium earths for which there is as yet but little use, it will be seen that the future of the monazite industry lies in the proper utilization of its possible by-products ; and cerium, though admittedly the most important of them, is not the only one, as we shall see in a minute. Only one per cent of the cerium goes to the manufacture of the gas mantles, which otherwise consist of 99 per cent thorium oxide. A further small quantity is absorbed in the manufacture of pyrophoric alloys. The little "flints" the smoker buys to put in his automatic cigarette lighter are made of this material. Fused in an electric furnace together with iron, these alloys contain about 30 per cent of iron to 70 per cent of cerium metals. When struck against steel, small particles are broken off and ignited at a low temperature emitting a shower of bright sparks, sufficient to ignite the wick soaked in petrol or alcohol.

This discovery was again due to Auer von Welsbach about the year 1907. The alloys were first of all made only at Treibach in Austria and in Germany, but during the war the supply was kept up by the United States. From 1,800 to 2,800 flints can be produced from one pound of pyrophoric alloy, so this side industry can hardly be expected to absorb all the cerium available. These alloys have also been used to define the flight of shells. A small piece of the alloy is affixed to the shell, and this bursts into flame through friction with the air shortly after leaving the gun, and so indicates its path at night. Here again, however, the amount used is too small to make much difference. Another 300 tons annually goes to the manufacture of arc lamp carbons. It has been found that carbons steeped in solutions of the mixed cerium salts burn with a steadier flame and emit a brighter light. An infinitesimal quantity is used therapeutically, but this is too small to take into consideration.

Zircon Sand.

During the magnetic separation process another by-product is accumulated, the zircon sand. This might be utilized in the future. Of the many uses to which zirconium has been put, perhaps the most important is the manufacture of refractory materials. As a refractory, zirconium is second to no other material. It is better than fire-clay, magnesite, fused silica, and alundum. In America already it is largely used and it is from there that the United Kingdom obtains its supplies. The zirconium is, however, not



Monazite Sands passing through the "Rapid" machine are automatically sorted by the revolving magnets.

obtained from monazite, but from huge deposits of a mineral, Brazilite, which occurs in the Caldas region of Brazil. There seems no reason why the large quantities of zircon sand, which must be accumulating at Travancore, should not take the place of the American material now on the British market.

A PROSPECTOR EXAMINING A DEPOSIT OF MONAZITE FOUND BY A WORKING PARTY.

The utilization of the black ilmenite, a compound of iron and a rarer metal called titanium, in the manufacture of white paint sounds like an inventor's dream, but there is no real reason why the ilmenite obtained from the magnetic separators should not be used up for this purpose. In Norway white paint is actually being prepared from ilmenite and sold under the trade name of "Titanvit." It is admirable for use in towns or for laboratory paint-work, as it retains its whiteness where white lead paints soon discolour owing to the sulphur compounds in the atmosphere. Being considerably lighter than white lead it goes further. Nine and a half kilos is sufficient to paint a surface of 100 square metres, as against 22 kilos of white lead. Should white lead be prohibited for the manufacture of paint, as it is to be hoped will one day be the case, here we have a substitute which is in every way as good and even better. The question of the cost of titanium paints is not a serious one, as, if more were used, it could be produced more cheaply.

Mesothorium.

Mesothorium is another of the possible by-products of monazite. To this substance the thorium compounds owe their radioactivity. It is used as a substitute for the more costly radium in the preparation of luminous paints. The material must "ripen" for several months after extraction before it is suitable for the manufacture of the luminous paint. During this period the α radiation increases in strength. Whereas radium has a long life, approximating to 1600 years, mesothorium has but a short existence of some six years. It is on this account very suitable for use in instruments which have only a short life, such as the dials in aeroplanes which have to be read at night. Though mesothorium is worth £3 to £4 per milligram, it is not, as yet, a profitable proceeding to extract it from the thorium nitrate, before the latter is used in the preparation of the gas mantles.

Lastly, from monazite is extracted a small quantity of didymium. A solution of the nitrate of this metal is used for marking the incandescent mantles. An organic dye, such as methylene blue, is added to the didymium solution to make a visible impression on the mantle as the solution otherwise is practically colourless. On ignition the organic dye is destroyed and the nitrate is converted into oxide which is deeply coloured and permanent. In this way the manufacturer records his name or mark.

The possibility of making proper use of all these by-products of monazite sand seems a very alluring one. It is to be hoped that in the near future full advantage will be taken of this product of our Empire. The writer wishes to express his thanks to Mr. Edmund White of Messrs. Hopkin & Williams (Travancore), Ltd., for information as to current prices of the sand

MONAZITE WORKINGS AT TRAVANCORE.

and mesothorium and also for the photographs of Travancore; to the *Pharmaceutical Journal* for the loan of the blocks from which these illustrations have been printed; and to The Rapid Magnetting Machine Company Ltd., for the diagram showing the working of their machine.

MEETINGS OF THE ROYAL ANTHROPOLOGICAL INSTITUTE IN FEBRUARY, 1925.

TUESDAY, 10th February, 8.15 p.m.—J. Reid Moir: "Further discoveries of Early Chellean Flint Implements in the Cromer Forest Bed of Norfolk." (Lantern).

Tuesday, 24th February, 8.15 p.m.—L. H. Dudley Buxton, M.A., F.S.A.: "The Stoney Indians of the Bow River, Alberta, Canada." (Lantern).

Listening to Electrons.

By John Elphinstone.

It has become a trite saying that the electrical development popularly known as "wireless" is still only in its infancy. New discoveries in the realm of electromagnetic energy are being made every day, and each further advance recorded makes it necessary to revise our past knowledge in much the same way as the modern chemist has been compelled to remodel the earlier theories of the elements.

At the same time our increasing knowledge of radio phenomena, often arising out of experiments originally framed to reach quite another end, has directed the researches of scientists to new paths of observation, some of which have been fruitful in astonishing results. A notable instance in point is found in the development by the Danish physicist Niels Bohr of the Quantum Theory of the energy of the electron first enunciated by Max Planck in 1900.

The function of the thermionic valve in wireless practice is now fairly familiar to many, though comparatively few pause to make themselves acquainted with the phenomena of the electronic flow. The wireless experimenter knows in a rough-and-ready fashion that when the filament of a valve is heated by means of an electric current, a stream of electrons flows from the filament or cathode to the plate or anode, and that the addition of a third electrode or grid makes it possible to control the flow of electrons by varying the potential of the grid with relation to the filament, and it is known that this procedure produces certain definite results. Beyond that point the average experimenter has apparently little desire to go, nor is it particularly necessary that he should. He has been enabled to hear WGY and KDKA, or even more distant stations, and he is content with that phase of his endeavours.

The more advanced investigator is by no means satisfied with mere results. He seeks a more intimate and more minute knowledge of the complex conditions by which these manifestations are surrounded, and in that aspect of research Dr. A. W. Hull, of the General Electric Company's laboratory at Schenectady, and Dr. N. H. Williams, of Michigan University have just recorded a very remarkable discovery.

They have made audible the blows of the electrons as they impinge like a shower of hailstones on the plate, and they declare that the sound of this invisible bombardment is like the noise of Niagara Falls heard at a distance.

We are brought here to a phase of research which verges on the marvellous. Thomson, Rutherford, Lodge and others have enabled us to measure the electron. We know that its mass is so minute that 1,000,000,000,000,000—one thousand million million ~~million million~~—electrons would have a mass of less than one gramme. nuff! And Dr. Hull and Dr. Williams have *heard* these electrons at work! Before the theory of the electron was propounded the atom was regarded as the most minute conceivable particle of matter. Sir Oliver Lodge, condensing modern research into a startlingly bold and striking image, has declared that compared with an atom, an electron would be like a fly in a cathedral.

In a report to the American Physical Society, Dr. Hull and Dr. Williams state that they made their discovery when measuring the electrical charge on the electron. The theory of the existence of this noise had been predicated by Berlin investigators, but never proved. Dr. Millikan, of the California Institute of Technology, carried the theory of the Schrot effect, as it is called, a stage further, but not to that of its definite establishment. Dr. Hull and his collaborator brought into use amplifiers giving a sound magnification of the order of 100,000 times, and thus not only found decisive proof of the Schrot effect theory, but were able to measure in this way the charge on the electron within an extremely high degree of accuracy.

The atom had already been heard. A device was invented in the laboratory of the General Electric Company which enabled their movement to become audible in a loud speaker. A magnet was brought into close proximity with a bar of iron and, as the groups of atoms in the iron changed their position under the influence of the magnet, the loud speaker recorded the rustling sound made by the atoms as they moved. Sir Oliver Lodge's "cathedral" was thus made vocal, as it were, and now the "fly" within it has also become audible. What will be the next step in the records of these researches into the infinitely little?

TRANSLUCENT OUTFITS.

Animal Adhesives.

By T. W. Jones, B.Sc.

Glue is one of those common things in everyday use which all of us overlook. Here is an article which gives some idea of the amount of modern science in the gluepot of to-day.

THE subject of adhesives is a good deal more extensive than might at first be imagined. After a few moments' consideration most people could probably give one some information about glue, fish glue, gum arabic, a few patent preparations, and possibly casein ; with sulphite waste liquors, pentosan derivatives, vegetable protein glues, jelly strengths, tenacity tests or the nature of collagen, they would, it is to be feared, display not the slightest acquaintance. These, however, are but a few of the multitude of items daily required by a chemist employed in the adhesives industry, and he must know them, as the saying goes, like his A B C. The employment of a staff of chemists by the manufacturer of adhesives is but one more example of the recognition of the need of science in modern industry, and is a development of but a few years. For thousands of years previously, carpenters had been in the habit of making their own glue. For exactly how many thousands it is impossible to say. Glue is one of those household commodities, the beginnings of which, like that of soap, is lost in the mists of antiquity. That it was well known to and in daily use by the carpenters of the time of Thothmes III, whom many scholars regard as the Pharaoh of the Exodus, is proved by the cartoons on the walls of the tomb of Rekhmara, near Thebes. In these are shown carpenters boiling glue, splitting wood into thin sheets for veneer, and glueing the veneer on to coarser woods. Pliny considered glue to be so old that he ascribed its invention, together with those of the axe and saw, to Daedalus (Plin. VII. 56).

Though the sources of adhesives are legion, they can be divided into two classes, vegetable and animal. The products of the former include the gums, such as gum arabic and tragacanth (highly valued for agglutinants for dyes and water-colour pigments), starches, and dextrins. The products obtained from animal sources, such as glue and gelatine, fish glue and casein, are the more important, as they are more widely manufactured and used.

Glue and Gelatine.

At one time any portion of the animal that could not be used for food, leather or buttons, piano keys or sausages, was thrown into the glue pot. To-day, however, discrimination is made between the various parts, according to the quality of glue or gelatine they yield. Before we go any further, it might perhaps be as well to say that glue and gelatine are really one and the same substance, with this difference, gelatine is the refined product and consequently the more highly priced. Both are extracted from skin, bones or leather, and by the same processes. The stock (bones, skin, etc.) is first "limed," that is to say, it is treated in large wooden or cement tanks, with an aqueous solution of slaked lime. This has the effect of swelling the collagen (a substance we will consider more fully presently), neutralising any acidity and clearing off any grease, besides eliminating the mucin, a protein which would produce a slimy, and therefore, valueless, glue or gelatine. After "liming" the stock is washed in mechanically agitated washers, and then passed to the boilers where the gelatine is extracted by boiling with water. Perhaps "boiling" is not quite accurate, since the boiling temperature is never reached, for it would produce a glue of doubtful adhesive or jellying properties. After "boiling," the liquor drawn off from the boilers is clarified by one of three methods.

(1) A mechanical method, such as settling or centrifugalising.

(2) An "absorptive" method, by the use of a bleaching substance such as bone black, which "absorps" the colouring matter.

(3) A chemical method, in which the colouring matter is precipitated by the addition of such chemicals as alum, etc.

Of these, the second method is considered the most efficient. The bleached liquors are then concentrated, chilled by pouring on to cold slabs of metal kept cool by water circulated over the underside, and then spread on nets to dry.

Chemical Composition of Gelatine.

Gelatine is one of the highly complex organic compounds called proteins. For our knowledge of the chemistry of these substances we are indebted to that famous chemist Emil Fischer, who was the first to synthesise some of the simpler proteins, and so show us how the more complex were built up from the amino-fatty acids. Collagen is the parent substance

of gelatine, and by boiling it with water we obtain gelatine by the chemical process known as hydrolysis, in which every molecule of collagen takes up a molecule of water to give the gelatine. Though all animal skin, muscle and bone contain more or less collagen, only one form of animal tissue consists exclusively of pure collagen, and that is the inner membrane of fish air bladders (" sounds ") which we will consider later. Gelatine, like collagen, being a complex protein, can be hydrolysed by boiling and it then gives less complex protein-like compounds known as peptones. These have little or no adhesive properties, and, consequently, it should be remembered that prolonged boiling of glue will result inevitably in decreasing its glueing value. It should, therefore, be avoided.

Acids, alkalies and micro-organisms also possess the property of destroying gelatine, and as the growth of bacteria and molds (which are included under the generic name of micro-organisms) is considerably favoured by the presence of moisture, glue and gelatine should be stored in a dry, cool place.

Among other substances capable of hydrolysing gelatine are the proteoclastic enzymes and the protein splitting enzymes. Enzymes, by the way, are complex organic nitrogenous substances, very similar in composition to these proteins, and they have the peculiar power of breaking up the heavier organic molecules into simpler ones. We are enabled to digest our food by the use of enzymes produced by different parts of the body ; it has been said that if we had the right enzymes in our stomachs, we could eat anything and be able to digest it. Two enzymes we all possess, which hydrolyse gelatine, are pepsin made by the walls of the stomach of most animals, and trypsin produced by the pancreas. Possessing these we can digest gelatine, which is probably as well considering what quantities of it are daily used in foods, such as ices and jellies, not to mention the amounts we daily consume in meats, of which the collagen has been partially hydrolysed by boiling. As a matter of fact, experiments have been made on several occasions to discover whether man could live on gelatine : the results have shown that he could not for any length of time, probably because gelatine lacks vitamines.

Glue and gelatine are used for many purposes ; far too many to give even a summary of them here. Because of this diversity, it is impossible to define the best glue ; it can be said, however, that for every purpose there is the most suitable glue. A good quality glue can be distinguished from a poor one by several easily applied tests. A good glue should be firm and free from cracks, or " craze " as it is called in the trade. It should be fairly translucent and in colour may be light amber or dark brown, but never black. It should not break easily and should not have a putrescent odour. If it has, it shows that hydrolysis and decomposition have commenced, and, consequently, the adhesive properties will be poor. It must, however, be remembered that bone glues always smell more strongly than skin or hide glues.

Fish glue, which is usually marketed in liquid form, is made from fish heads, bones and skins, that form the offal of the fishing industry. Most salting and tanning factories have their own fish glue plant, to utilise their waste products. The stock is first thoroughly washed, and then the glue is extracted in autoclaves under steam pressure. The subsequent evaporation is very similar to that used in the animal glue industry. Preservatives are usually added to fish glue to mask the fishy odour.

Fish Glue and Isinglass.

Isinglass, as the name implies, is obtained from the air bladders of certain fish, the sturgeon being the most important of these. The inner membrane of this consists of pure isinglass. The bladders or sounds as they are called are dried, the outer membrane removed, and the remainder chopped into small pieces, macerated between rollers and then passed to the sheeting rollers from which it passes to ribbon-forming rollers, and is there drawn out in the form of ribbons of about $\frac{1}{4}$-inch thickness and 6-8 inches wide.

Isinglass is more complex than gelatine and consists entirely of collagen. To convert it into gelatine it must be heated in water for a short time. Isinglass is chiefly in demand for the clarification of such beverages as wine, cider, beer and malt liquors. Its efficacy for this service lies in its purely mechanical property of maintaining a fibrous condition whilst in the liquid. On settling, therefore, the isinglass carries down any suspended matter such as starch granules, yeast cells and so on, which would cause turbidity. A single ounce of isinglass will clarify as much as 500 gallons of wine in 10 days. As an adhesive, isinglass is unrivalled for repairing glass, pottery, etc., and a suitable formula is as follows :—

Isinglass ...	10	grammes
Gum ammoniac	5	,,
Gum mastic ...	5	,,
Alcohol ...	80	,,

This has been used with marked success for many years.

Another most important animal glue is casein. The potentialities of this protein were not fully examined until the latter end of the war, although it had been in use for many years previous to that catastrophe for book-binding and cabinet-making,

although only on a small scale. The once popular reed furniture was often sized with a casein preparation, as the resulting pale cream colour was considered preferable to the amber colour produced by ordinary animal glues. The war, however, with its phenomenal advance in aeronautics created an imperative demand for a sound waterproof adhesive, since the ordinary animal and fish glues, though sufficiently strong for normal use, were unequal to the rigors of wet weather, on account of their susceptibility to moisture, which causes them to swell and so lose their adhesive powers. For propeller blades this could be prevented by painting with a waterproof varnish or lacquer, but the plywood used in the actual construction of the craft could not be so treated, consequently the need of an adhesive waterproof in itself was particularly urgent. Within a few months the Allied Governments commenced the production of casein on an unprecedented scale to supply this need, and to the knowledge so gained of the manufacture and behaviour of casein, we are indebted for our present information on the subject.

Milk Products.

Casein is the principal protein of milk, where it occurs in the colloidal form and is, as a matter of fact, what is termed a protective or stabilising colloid. It prevents the coagulation of the oil and water of which the milk emulsion consists, i.e., protects it from curdling. When milk turns sour, or ferments, the acid produced precipitates the casein and so allows the milk to curdle. This fact is taken advantage of in the manufacture of casein. The milk is first thoroughly skimmed, and then hydrochloric acid of special strength added to it in the form of a fine spray, whilst the skimmed milk is vigorously stirred by mechanical agitators; this curdles the milk by causing separation of the casein. The "curd," as it is called, is then allowed to settle and the whey is drained from the vat, leaving the curd behind. This is washed two or three times with clean water, after which the curd is put into a press and pressed dry. It is then cut into thin layers and spread on nets to finish drying.

The resulting casein must be mixed with alkali before it can be used as an adhesive; lime is generally used with other substances such as sodium fluoride, according to the particular formula in use, to keep the glue liquid. A fact that should be borne in mind is that most casein glues must be used as soon as possible after mixing if the maximum service is to be made of them.

Deterioration of Animal Glues.

This is a matter that claims everyone's attention, whether manufacturer, retailer or user. Animal glues, gelatine, fish glues and isinglass are particularly susceptible to the attacks of bacteria and molds. They should, therefore, be kept as dry as possible and stored in a cool place, and if possible in grease-proof paper, as ordinary paper is very hygroscopic and therefore favours bacterial growth. The fish glues usually contain preservatives, put with them to mask the disagreeable fishy odour by their stronger scent. Those most generally employed are oil of cloves, wintergreen and sometimes carbolic acid—or, to give it its chemical name, phenol; as these have powerful disinfectant properties, the growth of micro-organisms is considerably decreased. Animal glue and gelatine do not usually contain preservatives and therefore care should be exercised in storing them. It has been found that though casein glues are highly resistant to the action of moisture, they will ultimately decompose when exposed to a damp atmosphere for a long time. The Forest Products Laboratory of the American Government ascribe this to the chemical effects of the alkali necessarily mixed with the casein. Experiment shows that bacteria and molds will not grow on casein glues. Therefore they should be used as soon after purchase as possible, as prolonged keeping gives time for deterioration by the chemical action of the alkali, although bacteria appear to have no effects.

THE PHOTOMICROGRAPHIC SOCIETY.

SESSION 1924-5.

MEETINGS;—6th February, "Marine Algae," E. A. Robins, F.R.M.S., F.R.P.S.; 20th February, Members Evening; 6th March, "Silk Spinners and Leaf Cutters," F. J. S. Chatterton; 20th March, Members' Evening; 3rd April, "Exposure, and Hints on Illumination," Dr. D. J. Reid, F.R.M.S.; 17th April, Members' Evening; 1st May,* Members' Evening; 15th May, Annual General Meeting and Exhibition.

* Last date for sending in entries for the Barnard Medal and the Martin Duncan Certificate.

GEOLOGICAL SOCIETY OF LONDON.

THE Council of the Geological Society has this year made the following awards:—

Wollaston Medal, George William Lamplugh, F.R.S.; Murchison Medal, Herbert Henry Thomas, M.A., Sc.D.; Lyell Medal, John Frederick Norman Green, B.A.; Bigsby Medal, Cyril Workman Knight, F.G.S.Am.; Wollaston Fund, Alfred Brammall, Ph.D., M.Sc., D.I.C. Murchison Fund, Arthur Elijah Trueman, D.Sc.; Lyell Fund, James Allan Thomson, M.A., D.Sc., and William Alfred Richardson, D.Sc.

Book Reviews.

Outlines of Fungi and Plant Diseases. For Students and Practitioners of Agriculture and Horticulture. By F. T. BENNETT, B.Sc. Pp. vii × 254. (Macmillan & Co., Ltd., London 7s. 6d. net).

This book is a useful introduction to the study of Fungi and the diseases of crop plants caused by them. It will be particularly welcome to students of Agriculture and Horticulture, and it may also be recommended to all those farmers, fruit-growers, and gardeners who take a real interest in the plants they cultivate.

The book is divided into two sections. Part I deals with the study of Fungi in general and serves as an introduction to Part II, which is devoted to a description of the chief plant diseases caused by these organisms. In Part I there is a useful list of practical exercises to illustrate the structure and mode of life of Fungi, which could even be carried out by the home student possessed of the simplest apparatus.

Part II opens with a general discussion as to what is meant by disease in plants. Reference is here made to the enormous influence of weather and soil conditions upon the intensity of attack by parasitic fungi, and to the great differences in susceptibility to disease exhibited by the innumerable varieties of cultivated plants. It is well known that crop diseases cannot usually be controlled by direct attack upon the invading parasite; they can best be obviated by the application of indirect means such as, e.g., by the use of resistent varieties, by improvement in methods of cultivation, by the abolition of the sources of infection, and by preventive spraying with fungicides. Part II of the book contains a lucid account of the chief plant diseases prevalent in this country, together with information as to the best means of control. The author refers to legislation recently enacted in this country for prevention of the spread of such serious troubles as Wart Disease of potatoes and Silver-leaf Disease of fruit trees.

Although this book is generally a very readable and accurate account of plant diseases, there are some errors—for instance, the spores of *Stereum purpureum* are not purple but white in colour (p. 182), and the life-history given of the plum-rust (p. 217) is erroneous. No one acquainted with the chief plum-growing districts of the country could describe the disease known as "bladder-plums" as being extremely common, and it is misleading to state that the damage to wheat caused by yellow rust is similar to that of black rust, the latter disease, fortunately, being extremely rare nowadays in this country.

In spite, however, of minor blemishes of this kind the book fills a notable gap and should command wide appreciation among those for whom it is primarily intended. The book, which is abundantly illustrated, should serve to call the attention of the general reader to some of the most interesting phases of plant life.

F. T. BROOKS.

The Folklore of Bombay. By R. E. ENTHOVEN, C.I.E. (Humphrey Milford. Oxford University Press. 14s. net).

Many Indian civil servants have written valuable books on aspects of Indian life within their districts, but works on this subject and of this general standard of excellence are few and far between. Mr. Enthoven knows his subject and his people. This book will be a quarry of the utmost utility to oriental students and, what is more, will be of real utility to Indian civil servants charged with the administration of justice, the spreading of education and kindred functions of government. In these days of parrot talk about the self-determination of India it would be an excellent thing if would-be reformers in this country would read this book first and so gain an insight into the matters which really sway the minds of India's teeming millions.

The book covers an infinite variety of subjects dealing with all manner of customs and beliefs, witchcraft, tree-marriages, spirit possession, dreams, omens, women's rites, and miscellaneous beliefs and practices. An appendix gives a valuable series of questions on folklore suitable for examination papers. Despite this, the book has not the dryness of a textbook, but is extremely readable and astonishingly interesting.

Skill in Work and Play. By T. H. PEAR, M.A., B.Sc. (Methuen & Co. 4s. net).

This is one of those really good books which ought to be widely heralded and widely read. It does not profess to supply "tips," says the introduction, but this is rot because it does. The soundest possible tip to a learner is conveyed by the professor explaining the why and how of a particular point, and this book explains clear principles of self analysis both in work and in play.

In reviewing a book of this kind one argues from the general to the particular—and it is no bad method of determining a general value. Are Pear's ideas borne out in practice? Can I besides reviewing this book for DISCOVERY improve my tennis from some points he advances? The answer is undefeatable. You can. There is a lot of extraordinarily good stuff in general principles here. I commend the book to all games masters, coaches, and the rank and file who have an inferiority complex about ball or any games. The more serious side deals with applications of skill study to industrial problems and the extraction of better results by taskmasters who have summoned science to their aid. The redeeming feature is that there is less fatigue to the worker—so they say. In practice the commercial magnate avails himself of scientific production methods to cut piece rates and brings disrepute on the whole affair.

The education of the subconscious muscular sense varies with the individual, but Professor Pear's book can be trusted to teach even the worst bungler something. It is like a searchlight on the dark places of the mysteries of athletic proficiency. It is clear, easy to read, and the result of experience rather than the assimilation of new stunt theories. Highly recommended to all who can play games, and still more earnestly recommended to those who can't but long to.

The Riddle of the Pacific. By T. MACMILLAN BROWN. (Fisher Unwin. 30s. net).

Doctor T. Macmillan Brown, Chancellor of the University of New Zealand, has spent years studying the natives of the Pacific Islands and he is a scientist and ethnologist of standing. The result is a real book of observation and not a book made out of other people's books and the commentary of a fortnight's tour. The book was written on the island during a five-months' residence, and certain shortcomings of form may possibly be ascribed to this, the pre-occupations of research. It is a matter for regret that the author was not either better equipped with

Easter Id.

reliable photographic accessories or a better photographer. The illustrations are plentiful but poor work, and in these days a scientific explorer should no more neglect the photographic side of his work than go without a medicine chest.

The book gives a very exhaustive chronicle of early European contacts with the island, and a close study of the inhabitants; speech and customs viewed in relation in those of other Polynesian islands. According to his theory, the giant statues are the relics of a vast mausoleum suddenly abandoned before completion. To account for this the author holds that Easter Island was the centre or navel of a ring of archipelagos surrounding it. These have been submerged in volcanic cataclysms and now no trace of them remains.

This theory is closely in accordance with such facts as geologists have been able to ascertain from scientific investigation of Pacific islands. In many cases there is evidence of alternate subsidences and elevations. Ethnologically, Polynesia covers a greater space than any of the great world empires, and is occupied by people whose physique, speech and cultures are intimately related. They seem to have traditions that point to the slow subsidence and destruction of a vast Polynesian Empire. Easter Island, suggests the author, was their ceremonial burial island, a mausoleum of great warrior chiefs, good fighting men like the Marquesans. The present degenerate natives have been contaminated by European influences and diseases; but they were degenerate before the whites came, the suggestion being that they are a later invasion of the island by a race from the last subsiding point of a nearby archipelago. At first they were under the strong leadership of an autocratic king whose efforts preserved the race. At his death they lapsed into a disorderly democracy of decay.

The author does not pretend to solve the riddle of Easter Island by the adduction of evidence susceptible of proof, but he points to so many facts which his subsidence suggestion goes far to reconcile and explain, that he builds a very strong case for it. In any case, the book is very readable and interesting.

Memoir of the Geological Survey of Scotland. Tertiary and Post Tertiary Geology of Mull, Loch Aline and Oban. (15*s*. 9*d*.). Copies obtainable from H.M. Stationery Office, 120 George Street, Edinburgh.

This handsome volume is on the same high level as its predecessors on Skye and other parts of the Scottish Highlands. The work of the officers of H.M. Geological Survey is, of course, beyond criticism, even supposing the critic to have the knowledge and experience necessary to criticize. The country dealt with, together with Skye, Rhum and other of the Inner Hebrides and Antrim, contains the grandest scenic display of volcanics in the British Isles. This volume should be studied in connexion with the issues on Skye, etc. To the tourist with geological tastes the itinerary is of great use, and the historical chapter gives due credit to the distinguished geologist of the past—Judd-Heddle (mineralogist) and the late Sir Archibald Gukie—and traces the gradual growth of the knowledge gained by the research of late years. The photos and diagrams are very interesting—such as MacCulloch's tree, and the maps are extremely clear, so that even the most complicated tracts of Mull have a fair chance of being understood by the amateur.

The Purpose of Education. By St. George Lane Fox Pitt. (Third Edition. 4*s*. net).

The new edition of this valuable work embodies new matter, and is issued at a remarkably low price. It should be in the hands of all interested in educational problems.

Practical Microscopical Metallography. By Greaves and Wrighton. (Chapman & Hall. 16*s*. net).

The micro-structure of metals is now accepted as a fundamental branch of scientific engineering knowledge. In the past the literature of the subject has been diffuse and scattered in unhandy and inaccessible papers or interested rather in the morbid than the normal structure of metal and alloys.

This volume is a remarkably good piece of work. It satisfies the requirements of the works engineer and the science student alike. It is no mean achievement to produce a book which does this, for the engineer is not necessarily a man of wide scientific knowledge outside his own craft. The authors are to be congratulated on having produced a book which is in its very essence practical and efficient, and which does not assume a wide knowledge of optics and chemistry on the part of the engineering student. Surplus science is cut down to a minimum. All necessary facts are given and the detail of technique is clear and simple. The chapter on microscopic technique is a masterpiece of compression and yet absolutely up-to-date. It even includes the Chapman and Aldridge combined illuminator and objective, perhaps the greatest labour-saving device in metallurgical and petrological microscope equipment recently introduced.

The connected series of standardized micro-photographs used as illustrations to the basis of the book are admirable examples, and convey their lessons with a clearness no letterpress could hope to attain. The book is well thought out, well systematized and well accomplished, and can be recommended for use in engineering and metallurgical classes as well as for individual workers.

The Origin of Continents and Oceans. By Alfred Wegener. (Methuen & Co. 10*s*. 6*d*. net).

The Wegener theory is one of the most important points of controversy in modern geological thought. Right or wrong, it is an important idea and serves to reconcile many vexed points into a working basis for argument and discussion.

Professor Wegener believes that the continental masses are mainly "sial," that is, silica plus alumina, and that these masses float on a heavier mass the "sima," silica plus magnesia, which underlies the ocean beds and forms the body of the earth-crust of the globe. Roughly put his idea is that the continents are floating islands of "sial" moving slowly over the basic "sima." This is not liquid in the ordinary sense of the term, but viscid like sealing-wax and capable of yielding to slow movement under the stress of continuous forces.

Heat conservation from sedimentation, radio-activity as suggested by Professor Joly, or other causes might raise the "sima" to a semi-molten state where continental movement would be possible. The theory would explain the concept advanced from time to time that the geological evidence shows that the poles have shifted, and that glaciation and temperate climates have succeeded one another. In the past this has been difficult to reconcile, but viewed in the light of Wegener's conception, that at one time all the continental masses were together and have since drifted apart, it becomes a less contentious point.

The weak point in the theory is that so far no reliable measurements of this alleged continental drift have been obtained. In ten years' time we shall probably be able to say definitely whether or not this drift exists; until then the theory must remain in suspense. The book is of first-class importance to all students of geology.

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